Physiology Hygiene and Sanitation

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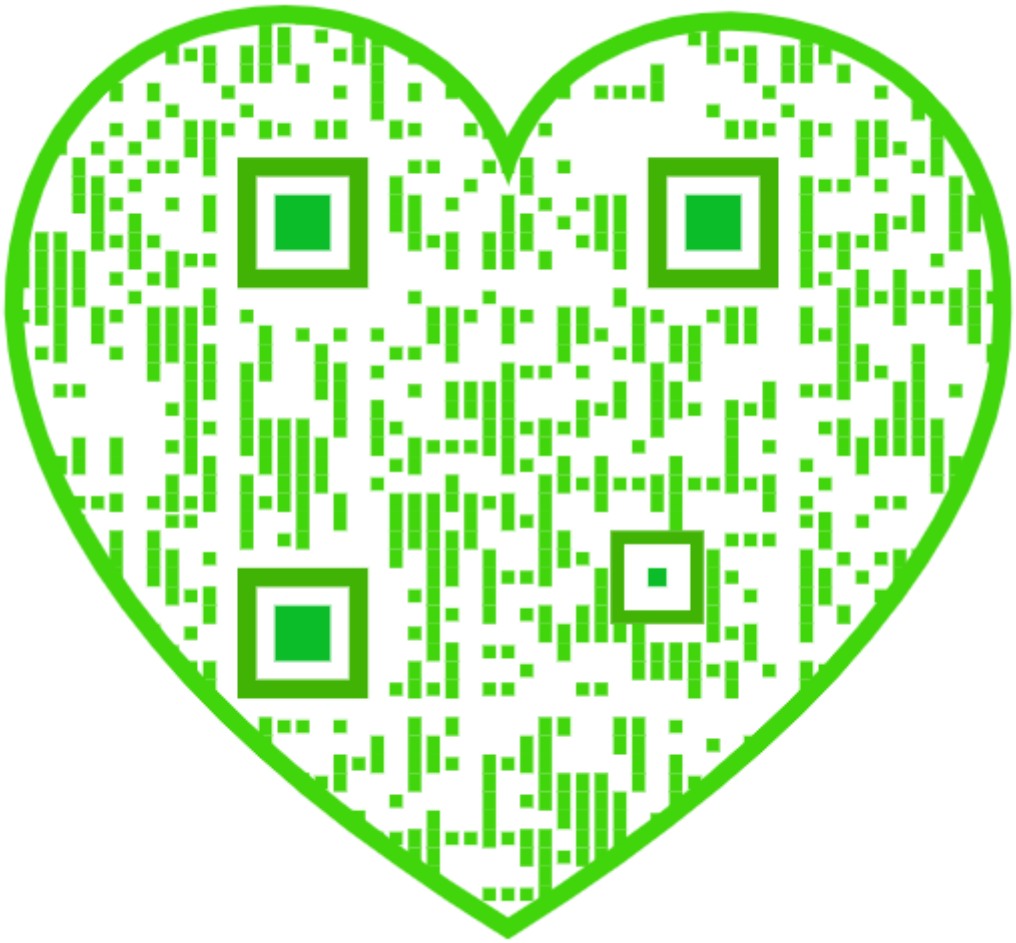

PHYSIOLOGY HYGIENE and SANITATION

An Elementary Text-Book of Physiology, with special attention given to Hygiene and Sanitation

BY

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INTRODUCTION

In the preparation of this book, one central idea prevails throughout—that of application of such knowledge to the life of the individual and the community that health may be preserved. Enough physiology is given in its relation to gross and minute anatomy to make clear the laws of health and the necessity for obeying them.

The writer realizes that it will be a long time before we shall cease to have opportunities to become infected with diseases that will be spread by careless, indifferent or ignorant people, but the effort is made in this book to create a health conscience so that when a communicable disease attacks an individual who knows how such diseases are spread, he will feel morally bound to try to limit it to his own household. When the public is educated to this degree, the spread of such diseases will be prevented to a large extent.

No apology is made for a frank discussion of the diseases caused solely by the carelessness in disposing of body wastes. A large number of people are dying each year of typhoid fever, dysentery (flux) and "summer complaint" (diarrhoea and enteritis) in children, every school district in the state being represented. These and many thousands more of our citizens are being made seriously ill because we have been too modest to tell our children that these body wastes are poisons.

The necessity for an efficient local and state board of health is made plain so that, with proper sentiment demanding it, the state and local laws for the protection of the people may be enforced.

Why do we need a practical, health and life-saving physiology? The records of death on file in the Bureau of Vital Statistics of the State Boards of Health show that of the deaths registered nearly one-half are due to diseases that are practically preventable.

There are today in every state thousands of people, who recently attended our public schools, who do not know that tuberculosis, typhoid fever, diphtheria, and many other diseases come from seed (germs) and that to prevent these dreaded diseases, one has only to prevent these seed from being scattered and grown in other people.

As a result of this lack of information about one of every seven funerals that occur is caused from tuberculosis (consumption) and thousands who are ill of it are scattering the seed in every community so that about one of every seven of the children, for whom the state is now spending millions of dollars to educate, will die of this disease, and nearly one-half of them will die in the prime of their lives of diseases which are practically preventable, unless they are taught the means of saving themselves.

Many thousands of our people shorten their lives and become less efficient by the use of tobacco and alcohol; through ignorance of the value of pure food, water and air, and as a result of immorality. The school physiology is not complete if it does not arm the individual with the knowledge and purpose to avoid these errors and enable him to live in harmony with the laws of health.

The people spend foolishly a vast sum of money for patent medicines, many of them containing poison and alcohol, which usually do not do any good and may do a great deal of harm by the formation of a "drug habit"

or by delaying the proper treatment of a disease until all hope for cure is lost.

The average state pays to her dentists each year hundreds of thousands of dollars for constructing and repairing teeth. With the kind of knowledge that compels one to keep the mouth and teeth clean, and in the absence of disease, no one need pay a dentist much for repair, except as a result of an accident, or need suffer any of the terrible pain of neglected teeth.

From these considerations, it is evident that we must teach the children of today, what we, yesterday, did not know about the causes and prevention of disease that, tomorrow, the people may live longer, happier, freer from sickness and be able to carry on the warfare against disease with less opposition from ignorant people who must be protected in spite of themselves.

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CHAPTER I

THE HUMAN BODY A MACHINE

A practical knowledge of any machine results from a study of its use; its structure, or of the various parts composing it; its motive force, or power to make it work; its operation, or the way to make it work; the care of it, to keep it useful, and the repair of it should it be broken.

If this kind of knowledge were applied to all machines upon the farms and in the factories, they would do their work better for a longer time, at less expense and save their owners a great deal of worry, time and repair bills.

Some machines are so simple they can be understood at a glance, while others of complicated construction, like a watch, harvester, steam engine, linotype machine or a sewing machine, require careful study to understand their construction and remedy their ills. Machines costing a great deal of money are given expert care and attention to keep them in order and preserve them.

The human body is the most wonderful machine in the world. It is made up of millions of parts which work in harmony; it furnishes its power, wears out millions of parts every day and replaces them with new ones which it makes; it fights its battles with disease and superintends all its operations within itself; it has time left to gird the earth with the railroads, telephones, and telegraph and give us literature, music, arts and sciences and direct all the human activities of commerce and society.

A practical knowledge of the human body will be gained by the study of it as a machine.

Our happiness and success in life depend upon our good health. The body is said to be in good health when all its parts are doing their duty perfectly and in harmony.

One may spend long years of study and a great deal of money to secure a good education, yet, if he fails to care for his body and protect it against its enemies, his efforts may be wasted because of ill health or he may die from a disease which can be avoided. Recall six of the most successful people you know. How many of them have been sickly all their lives?

Sickness or illness is that condition of the body in which some of the parts are not doing their duty perfectly and in harmony.

The human body is such a complicated machine that thousands of men have spent their whole lives in its study and were never able to learn all about it. If all the books and papers that were ever written about the body were collected in one place, it would take a lifetime to count them.

The science or study of **medicine** includes all that is known of the human body. Those who devote a great deal of study to this science are called Doctors of Medicine. They are required to study the physiology, hygiene and pathology of the human body and many other branches of the science. Each of these subjects and many other branches of the science require a large book of more than a thousand pages to tell what is known of the body.

The purpose of **this** book is to give us enough knowledge of the physiology, anatomy, hygiene and pathology of our body to keep it well by obeying the laws of health.

Anatomy is the study of the parts of the body.

Physiology is the study of the functions or uses of the parts of the body. Hygiene is the study of the laws of health. Pathology is the study of the diseases of the body or the conditions which make the body sick.

If we could imagine that these terms could be applied to a watch, for example, the physiology of the watch would tell us of the function or work of its parts. The wheels, moved by the spring, would turn the long and short hand to the letters or figures on the dial to tell the time of day, while the second hand moves around on the axle of one of the wheels to warn us of the passing minute. The anatomy of the watch would describe the parts; the wheels, spring, long and short hand, the dial or face, second hand, axles, etc. The hygiene of the watch would give us the rules to keep it in repair and directions to keep it from running too fast or too slow. The "pathology" would describe a broken spring or jewel, axle or any of the "diseases" which would hinder it from keeping the correct time.

Summary

A study of its use, the parts of which it is composed and their uses, the method of its operation and its motive power, its repair and its care constitute a practical knowledge of any machine.

The human body is best studied as a machine to acquire a practical knowledge of it.

The complete knowledge of the body is embraced in the science of medicine.

Well-trained physicians are experts in the care of the body because they have a practical knowledge of the

anatomy, physiology, hygiene and pathology and other branches of the science relating to the care of the body.

The purpose of this book is to give one enough knowledge of his body to keep it well and protect it against its enemies.

Questions

1. Why is the human body like a machine?
2. What are the necessary things to know about a machine? The body?
3. Why is it necessary to study the human body?
4. Which is most to be desired, a splendid education, wealth or good health? Why?
5. What makes you think the body is a complicated machine?
6. What is health? Sickness?
7. What is the purpose of this book?
8. Describe what may be called the physiology of a sewing machine; its anatomy, hygiene, pathology; a steam engine; an automobile; a school.
9. Tell what we mean by the physiology, anatomy, hygiene and pathology of the human body.
10. Mention five things the human body does within itself.
11. Name five things which you think are the greatest the human machine has done for us.

CHAPTER II

THE SYSTEMS OF THE BODY

Gross Anatomy. Viewing the body as a whole, it is found to consist of three divisions; the head, trunk and limbs. The head is made up of the cranium and the face, and contains the brain and organs of special senses—the eyes, ears, nose and the tongue. The trunk is made up of two parts; the chest, which contains the heart and lungs, and the abdomen, which contains the stomach, liver, intestines and other organs of digestion. The limbs are described as the upper and lower extremities, or the arms and legs.

The examination of the materials composing the body shows that it is made of bones, muscles, fat, blood vessels, blood, lymph, nerves, cartilage, connective tissue and skin.

The bones, muscles, blood and other parts of the body have certain duties to do. Each system has a special task to perform.

It is necessary to study the body by systems in order to get a knowledge of its parts, use and care.

The Systems of the Body. A system of the human body is any group of parts which perform in perfect order their particular duty. There are seven great systems of the human body. The muscular system gives to the body its power of movement; the osseous or bony system gives to the body its shape and rigidity; the digestive system prepares the food which is converted into force and flesh.

The circulatory system carries the blood and lymph

to all parts of the body; the respiratory system furnishes means for supplying the body with air and ridding it of certain poisons; the excretory system rids the body of its refuse matter and poisons, and the nervous system controls and guides all the work of the body.

Each of these systems will be studied separately, but it must be remembered that all are so closely connected and work in such perfect unity that if one system becomes impaired it will affect the work of all of them. Thus, if a bone is broken, it interferes not only with the work of the muscles but the work of all of the systems of the body.

Organs. Any part of the body which has a special task to perform is called an **organ.** Thus, the heart is the organ which pumps the blood. The stomach is the organ which helps digest the food. The lungs are the organ which purify the blood by exchanging oxygen of the air for poisonous gases. The brain is the organ which helps to control the workings of the body. The eye is the organ of sight and the ear of hearing. One cannot live if the heart or lungs or brain stop working for even a short length of time. These three organs have been called "The Tripod of Life."

The steam engine may be powerful enough when working properly to draw a heavy train of cars, yet, if one of the wheels break, the throttle refuse to work, or the boiler sustain a serious leak, not only the engine but the entire train will be brought to a stop until repairs are made. That engine is useful and powerful only so long as all of its parts are performing their duties perfectly and in order.

It is so with the human body; it may be digesting its

food, moving itself about, breathing regularly, pumping its blood, ridding itself of poison and governing its operations, yet, if part of it is injured by a severe blow, cut, frozen or becomes poisoned by disease germs, or for any other reason is seriously damaged, the entire work of the body is halted or stopped until repair is made.

It is important that we protect the body from accidents or other injuries, and it is of special importance that the body be protected from sickness which is caused by impure air, food and water and other diseases which can be avoided.

Sickness. A great deal of sickness and many of the deaths that occur are caused by diseases practically preventable, and among these are tuberculosis or consumption, typhoid fever, small-pox, scarlet fever, measles, whooping cough, la grippe, influenza (sometimes called Spanish influenza) and "summer complaint of children." These and other diseases will be studied under the systems of the body which are directly affected, but it must be borne in mind that any disease affects the work of the entire body. In no other way is the truth of the motto, "United we stand, divided we fall," better shown than in the work of the systems of the human body.

Summary

The gross anatomy of the body shows it to be of three main divisions, the head, trunk and limbs, and that it is composed of bone, blood, lymph, muscles, tendons, fat, blood vessels, connective tissue, nerves and skin.

It is found to consist of a number of systems, each of which performs a special task. In health all the systems

of the body perform their tasks in conjunction with each other.

Any interference with a single system hinders the work of every other part of the body. Many diseases and accidents are preventable, and it is our duty to avoid them.

Questions

1. What is meant by gross anatomy?
2. Name three divisions of the body and their parts.
3. What materials compose the body?
4. What is meant by a system of the body?
5. Name seven systems of the body.
6. Describe the physiology of the muscular system, the osseous system, the digestive system and the other four which are mentioned.
7. What is an organ? Name three which are called "The Tripod of Life." Why?
8. Name four other organs of the body and their functions.
9. Explain what is meant by saying, "The work of the body may be likened to the work done by a machine."
10. Name five rules for general hygiene of the body given in this chapter.
11. What is meant by preventable sickness? How may such sickness be avoided?
12. Name nine diseases which can be prevented.
13. Where in this book will they be described?
14. What is the motto which applies to the work of the systems of the body?

CHAPTER III

BODY CELLS

Minute Anatomy. In the last chapter the gross anatomy of the body was considered. The eye unaided by any instrument is able to see that the body is composed of bone, blood, muscles, nerves, skin, etc. To understand fully the workings of the body and how to protect it, it is necessary to take a closer view of the parts and see how they are constructed. They are made up of objects so small that they cannot be seen with the eye alone, but can be seen only with the aid of the microscope. Such an examination of an object is termed a **microscopical examination.**

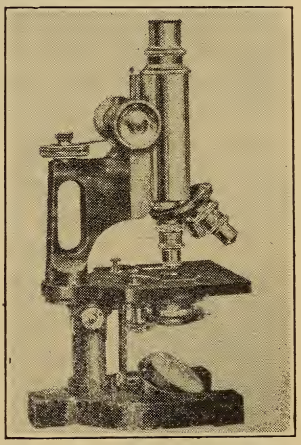


Fig. 1. — A microscope with which to magnify objects too small to be seen with the unaided eye.

When an object is seen at a distance of several miles it may be difficult to say whether it is a dwelling, barn or some other object. Upon coming closer to it, we see it is made of bricks and we can see the mortar between them. Upon examination, we may see the grains of sand in the mortar. With the aid of different lenses these grains of sand may be enlarged until they appear as great stones.

Blood when examined by a microscope is found to contain millions of tiny round objects called cells. Likewise,

the bones, muscles, fat, skin, nerves, blood vessels and every part of the body are found to be made up of a great many tiny parts, so small usually that many hundreds would have to be placed end to end to reach an inch. All these tiny parts are called cells. A cell is known as the smallest division of living matter. In health, each cell retains its own identity; that is, a blood cell never becomes a fat cell or a bone cell or a muscle cell, neither does any cell become a cell of another **tissue.** A tissue is any part of a living body which is made up of cells.

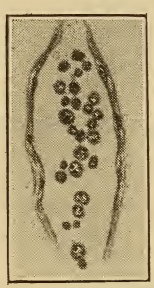


Fig. 2.—Blood cells (magnified) in a small blood vessel.

The body is a mass of cells which make up the bones, muscles, nerves, blood, fat, blood vessels, skin and other tissues of which the body is composed.

The human body, like all other animals and plants which are found upon the earth, starts from a single cell, and, by dividing and growing, forms the entire body. The body is repaired by replacing new cells for those injured or worn out. Every motion of the body, every thought, every act of the body causes many cells to be destroyed.

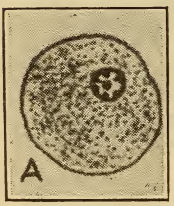


Fig. 3.—A highly magnified body cell.

Good health depends upon good cells. When the body is in good health new cells are formed at once to take the place of those worn out or injured.

In sickness, cells are destroyed much faster than new ones can be made to take their places. When too many cells are destroyed death of all the cells occurs and the body is said to be dead. A person who is recovering

from a severe injury or illness is said to "look thin" or to have "lost flesh." This is only another way of saying that many more cells have been destroyed during his sickness than have been made to take their places.

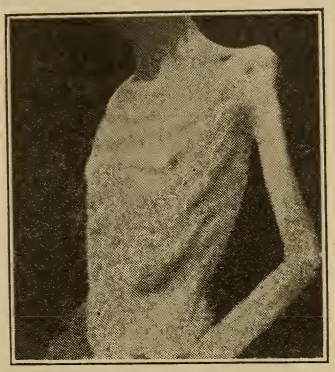


Fig. 4.—The man looks "thin." The germs of tuberculosis (consumption) have destroyed millions of his body cells.

Cell Enemies. Any condition or habit which destroys cells faster than they can be replaced results in impairment of the body. Keeping late hours at night deprives the body of the time to repair itself, and a person persisting in this habit becomes less efficient or ill. In the same way, the body is affected by bad air, water and food, by alcoholic drinks and exposure to too much heat or cold and accidents.

Fig. 5.—The tiny dots are "germs or bacteria" in blood. The larger bodies are blood cells (highly magnified).

Germs or bacteria are responsible for more than one-half of all the sickness of the world. They are, therefore, the worst of the cell enemies. They are microscopical in size, being so small that many thousands laid side by side will not cover the distance of one inch.

Summary

Minute Anatomy is a branch of science which treats of the smallest parts of which the body is composed. Such a study can be made only with the microscope, an instrument of many lenses which has the power to magnify an object and make it appear much larger than it is.

Fig. 6.—The dotted lines point to two parts of the lung which have been destroyed by the germs of "consumption."

The cells composing the entire body are readily seen with such an instrument and the difference in size, shape, color or texture may be observed.

The body is constantly being destroyed by loss of cells. In health they are replaced immediately.

Sickness and death are caused by cells being destroyed faster than they can be replaced.

Consumption or tuberculosis, typhoid fever, pneumonia and diphtheria and all the diseases which are called "catching" are caused by bacteria or germs, which are the worst of all cell enemies.

Questions

1. What is minute anatomy and how does it differ from gross anatomy?

2. Explain what is meant by a microscopical examination of things.

3. What is a cell? Name six kinds of cells in the body.

4. How is the body repaired? How destroyed?

5. What happens to the body cells in health? In sickness?

6. What is meant by a person "looking thin?" Being dead?

7. Name seven cell enemies. How do they effect a person?

8. What cell enemies are responsible for more than one-half the sickness of the world?

9. Recall ten people you know who have been sick or who have died. How many of them were sick or died of the disease which you know can and ought to be prevented?

CHAPTER IV

CELL ENEMIES

Bacteria. Germs or bacteria are found everywhere in nature; in the air, water, and soil. They belong to the vegetable kingdom and are the lowest form of vegetable life. They are made up of single cells, microscopical in size, and increase with great rapidity under proper conditions. There are many thousands of kinds of bacteria, most of which are entirely harmless to the human body. A great many bacteria are helpful while a few produce diseases when they get into the body and grow.

Helpful Bacteria. If a clover plant is pulled from the ground, there will be found, probably, little white balls or nodules attached to the roots. If a piece of this nodule is placed under the microscope it will be found to contain a great number of bacteria which gather nitrogen from the air and hold it in the soil. For this reason the cultivation of clover, soy beans and cow peas and other leguminous plants is undertaken to improve the quality of the soil. Without the presence of these germs, the growth of these crops would be far less valuable.

The United States Department of Agriculture will furnish the farmers a supply of these germs and directions how to grow them. Before sowing clover seed, cow peas or soy beans they are sprinkled with a fluid containing these germs so that when the plant grows these bacteria will be in the soil, which will add to the value of the crop.

Besides these helpful bacteria, a great many bacteria aid in destroying dead animals and other refuse matter so that we are rid of a great many unpleasant odors and

disgusting sights. The sewage or wastes of any city, community or family may be safely disposed of by allowing certain bacteria to destroy it.

The yeast plant is one of the best known germs, being used in homes to make bread. All fermentation is caused by the growth of this tiny plant.

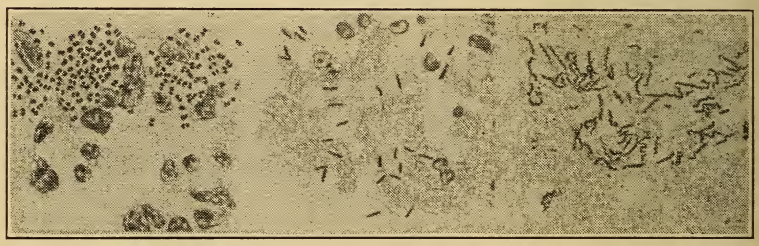
Helpful bacteria are used in the manufacture of cheese and butter. Their growth in milk is responsible for its souring. A drop of sour milk placed under the microscope will reveal thousands of bacteria. Buttermilk, one of the best of foods, contains millions of bacteria which are responsible for its flavor. Such germs have been called "friendly germs."

Harmless Bacteria. Most of the bacteria found in nature are harmless. Water taken from ponds, cisterns and wells might contain a large number of different kinds of bacteria, and yet not always be harmful if taken into the body. Their presence in drinking water, however, is a sign of danger, and it should not be used, unless thoroughly boiled.

Fig. 7.—Yeast cells as they grow in "home-made" yeast bread.

Harmful Bacteria. A few of the bacteria are known to

produce diseases when they are planted and grown in the body. They may be called the "seed of diseases." They are also called **pathogenic** bacteria. Open sores upon the body, "boils," "pimples," erysipelas, "blood poison," tuberculosis, diphtheria, membranous croup, typhoid fever, dysentery (flux), "summer complaint of children," pneumonia, la grippe, "granulated lids," "sore eyes," and many other diseases are caused by these microscopical plants getting into the body and destroying cells and many times some of them destroy enough cells to cause death. In the same way it may be said that measles,



A B C

Fig. 8.—A. round germs (cocci); B. rod-shaped germs (bacilli); C. spiral-shaped germs (spirilla).

scarlet fever, whooping cough, small-pox, chicken-pox and mumps are caused by the growth in the body of bacteria. A **bacterium** is usually so small that thousands of them can find room in a drop of water hanging from the point of a needle. They are from one-ten-thousandths to one-twenty-thousandths of an inch thick, or, in other words, about five hundred of them laid side by side would not cover more space than the thickness of a hair. They can only be seen as small objects when placed between thin pieces of glass under a microscope which will make them appear to be seven or eight hundred times larger than

they really are. Even then they look to be no thicker than the dot of an "i" on this page.

Shapes of Bacteria. A germ may be round like a grape or marble, in which case they are called cocci (singular coccus). Some are shaped like a small piece of pencil, in which case they are called bacilli (singular bacillus), or they may have the shape of a spiral like a corkscrew, in which case they are called spirilla (singular spirillum).

Summary

Germs or bacteria are the smallest form of vegetable life, and are found everywhere in nature. They are of the simplest construction, being a single cell.

Most of them are harmless to men. Many of them are friendly to man, and few produce diseases when they grow in the body.

Helpful bacteria are used to enrich the soil, to make bread, cheese and butter. They may be used to make harmless the wastes from a city or home and to destroy decaying animal or vegetable matter.

They are of three shapes and are named the coccus, bacillus and spirillum.

Water from ponds, wells and cisterns may contain many bacteria that are harmless. Such water contains surface water, and should not be used for drinking or cooking purposes. When disease germs are deposited near such places, a person drinking the water may develop typhoid fever or other diseases.

Disease germs are called the "seed of disease" and when planted in the body may cause typhoid fever, tuberculosis, consumption, diphtheria, membranous croup, whooping cough, scarlet fever, "granulated lids,"

"sore eyes," pneumonia, la grippe, "bad colds," smallpox, chicken-pox, and many others. Such germs are called **pathogenic bacteria.**

Questions

1. What is a germ or bacterium? Illustrate the size of bacteria.
2. What shapes may germs have? What is a coccus? What is one called when shaped like a fire cracker? A spiral?
3. Where are harmless bacteria sometimes found? What is the danger of finding them there? How can you know a well or cistern receives surface water?
4. What are nitrifying bacteria, and where may they be found? What is their value?
5. How may nitrifying bacteria be sown in the soil?
6. Name five helpful things which bacteria do?
7. What do we mean by the "seed of disease"? What is another name for them?
8. Name fifteen diseases which they produce? What is necessary before they can produce these diseases in the body?

CHAPTER V

BACTERIA

How to Grow Bacteria. If a small piece of yeast cake which contains the yeast plant or germ be placed in a bottle with a thin mixture of water and boiled potato and set in a warm, dark place, there will be seen bubbles of gas (carbonic-acid gas) form on top of the mixture. This is caused by the growth and reproduction of yeast plants. In a few hours there would be found many thousand times the number planted. "Home-made" yeast bread can be made beginning in this manner.

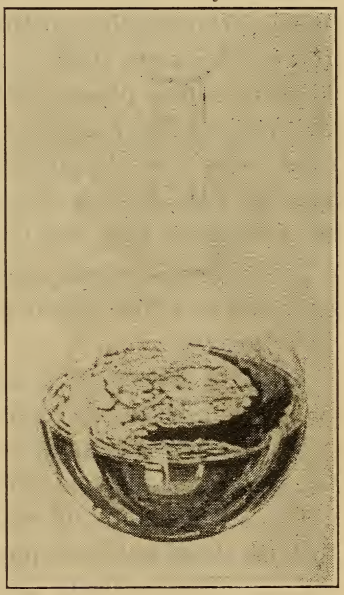


Fig. 9.—Germs of tuberculosis grown in a pint flask. Countless millions are seen in the white mass floating in the bottle.

Growth of Germs. Germs grow only in the presence of moisture, food, warmth and absence of sunlight. The germ of life in a grain of wheat, corn or other seed, is kept from growing for many months or years because most of the moisture in the grain has been removed. (Weigh carefully a dry grain of corn. Place in a box of good soil which is kept in a warm place. In five days weigh it again and

see how much it has gained in weight by absorbing water. See if the germ is growing.)

(Place a piece of yeast cake in some dry flour and keep in a dry, warm place. See if it grows in twenty-four hours. Why? Make a thin paste of some flour and water and place some of the yeast cake in it. Set it in a warm, dark place and examine after twenty-four hours. What happened? Why?) Apples and other fruit "spoil" by reason of destructive germs growing in them. If enough moisture is extracted from such fruit it may be kept from "spoiling" for a long time when kept in a dry place. Why is it necessary to keep in a dry place? Such fruit is called "dried fruit," "evaporated fruit" or "dehydrated fruit." New string beans may be kept for winter use by exposing them in an oven to a uniform heat sufficient to dry them. Why?

Most germs when once dried are dead and will not take on new life when placed in proper conditions for their growth.

Food of Germs. A grain of wheat, corn or other seed contains in the "heart" the germ of its life. Nature has surrounded it with food to last until it begins sending out roots into the soil to get its water and food.

Place ten grains of corn in a clean saucer, fill it half full of clean pebbles, pour in water until it covers the stones. Watch from day to day and note how long it will be before the plant uses up all the food. Why did they grow at all? Why did they die? How would you have continued their life?

Bacteria, like all other living plants or animals, must be supplied with food. Milk, thin soups, blood serum, gelatine, raw potato and fresh meats are some of the foods which will supply many bacteria with food.

Warmth for Germs. Place a few grains of wheat or corn in a small box of good soil which is moist. Place it where it will be cold and see if it will grow. Place a piece of yeast cake in the potato and water mixture and set it in an ice box for twenty-four hours. What happened? Why?

Seed which lie in the ground through the winter months begin to grow when the sun furnishes them sufficient heat. All the conditions necessary for their growth except warmth were present during the cold months. Germs, like the higher form of vegetable life, will not grow unless they are supplied with warmth.

Absence of Sunlight. Most plants require sunlight for their growth. Bacteria are so delicate in their structure that most of them are killed when exposed for some time to the light of the sun. They grow better in dark places. The diseases which are caused by germs are more likely to develop in homes and rooms which do not admit sunlight.

In sunshine, nature has given us one of the cheapest ways to kill disease germs, and to protect ourselves against sickness which they cause. Bed clothing, rugs, carpets, curtains and clothing should be exposed for a few hours to the strong sunlight every few days to purify them. This should be done in every case when one is ill, has recovered or has died from one of the "catching" or germ diseases. Many lives that are now being lost from "consumption," typhoid fever, scarlet fever, measles, etc., could be saved if every one would use this simple means of killing the "seed of disease," and much sickness and suffering could be prevented.

How Disease Germs Are Spread. Bacteria produce sickness by growing in the body where there are warmth,

food, moisture, and absence of sunlight. They grow and multiply very rapidly and throw off poisons which consume the body cells and many times cause death.

Disease germs may escape from the body through the nose, skin, lungs, throat, bowels or kidneys. The germ of consumption (tuberculosis), for example, will escape from the lungs through the mouth or nose in most cases, although the germ may attack any part of the body, in which case it may escape in other ways.

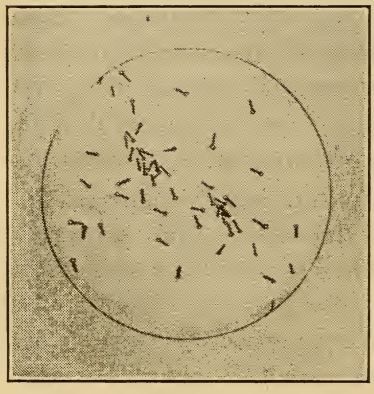


Fig. 10.—Germs or "seed" of "lock-jaw" (tetanus). Notice the club-shape.

It is impossible for any person to "catch" one of these diseases unless the seed or germ of it is placed in the body and grows. It is no more possible to have typhoid fever, for instance, without swallowing some of the seed or germs than it is to grow a stalk of corn without planting the grain of corn.

There are many ways by which "seed of diseases" may be scattered and planted in the body. They may be found in impure air, water, milk, or other food or soil. They can be carried by flies, rats, cats, mice, drinking cups, towels, wash basins, unclean hands and many other ways.

How Germs Are Killed. Bacteria and germs are best killed by burning or boiling. Any living thing when exposed to intense heat is finally killed. Germs, therefore,

being very delicate living plants, are easily killed with heat.

Bedclothing, wearing apparel, dishes, knives, forks, spoons and drinking glasses, used by a person ill of one of the germ diseases, should be boiled for fifteen or twenty minutes before being used by any other person. Every person who has been ill or who has died of tuberculosis, typhoid fever, diphtheria, or any of the germ diseases, was made sick because the seed of the disease from some one else were not destroyed.

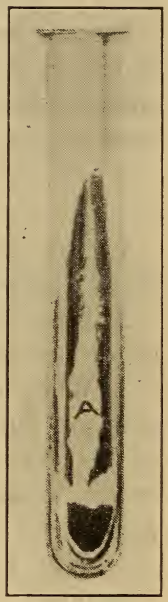


Fig. 11.—Germs of diphtheria grown in a test tube. Millions are in the mass. (A).

Summary

Germs will grow in the presence of moisture, food, warmth, and in the absence of sunlight.

The canning of fruits and vegetables is successful only when the knowledge of the growth and destruction of bacteria is applied to their preparation. "Dried fruits" and vegetables "keep" because most of the moisture has been reduced, and all the germs have been killed.

The use of sunshine during and after sickness and after death from a preventable disease to purify the room and its contents helps prevent the spread of illness.

Bacteria produce sickness and cause death by growing in large numbers in the body and making poisons which destroy the body cells.

Each disease is produced by a particular kind of germ, and it is impossible to be ill of such a disease unless that germ or seed is planted and grows in the body.

Disease germs are scattered and sown in many ways; in water, milk, or other food, by flies, rodents, domestic animals, unclean hands, drinking cups, towels, and wash basins.

Questions

1. How can "yeast" be made for making "home-made" bread?
2. What is yeast? Is it a germ? Why? What are the conditions necessary to grow germs?
3. What happens when a grain of corn, wheat or other seed are put in warm moist soil? What is nature's way of preserving seed? How do you account for the increase in weight after a seed has been planted in the ground for a time?
4. Why does "dried fruit" keep? What is meant by "keeping?"
5. What causes canned tomatoes or other fruit to "spoil?" How is this prevented? Why?
6. Why will not apples, peaches or other fruit rot or sour when they are cut in small pieces and scattered and exposed to the hot sunshine for a few days?
7. What is nature's way of killing germs? How would you apply this fact in your home in sickness caused by germs?
8. How do the pathogenic germs or the "seed of disease" produce sickness and death?
9. Can one become ill of "consumption" by getting into his body the germs of typhoid fever? Why?
10. How are germs scattered?

11. Explain at least four ways by which disease germs may be prevented from growing in the body. There are four more laws of hygiene in the same paragraph. What are they?

12. What is the best way to kill germs?

13. How would you make safe for use, germ-laden clothing, carpets and eating utensils? What diseases may be spread by such things, if not properly handled?

14. Why do the germ diseases continue to cause illness and death of our people?

15. In what other ways may disease germs be killed?

CHAPTER VI

THE OSSEOUS SYSTEM—THE SKELETON

Uses of the Bones. The bones have three important uses. First, they are the framework of the body and give it support and retain its shape. The bones being hard and more or less rigid, the shape of the body after full development remains about the same from year to year. From birth to the age of twenty-two to twenty-five years the bones grow in length and size.

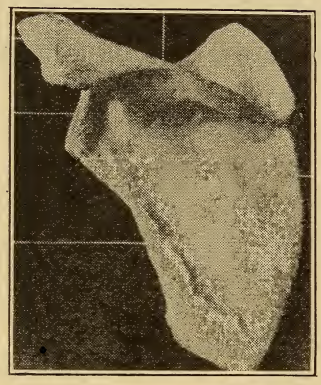


Fig. 12.—The shoulder blade (scapula). It is broad and flat for the attachment of muscles.

Second, the bones act as levers upon which the muscles act to produce motion. Without the bones the body would be a shapeless mass of flesh and would flatten like wet clothes when laid upon the floor. The muscles, which act like rubber bands when stretched, would be unable to move the body about because there would be no rigid support for them to pull against. If one tried to move the arm without the bones in it, it would bend in every direction like a half-stuffed stocking. The fingers without bones would be like small rolls of soft pulling-candy and refuse to do their thousands of operations.

Third, the bones help protect the delicate organs. The eye, for example, is set in a bony casing so that it is well

protected from blows, etc. The brain, the most delicate of all organs, is placed in a bony box so that it may be secure from ordinary falls, knocks and crushes.

The heart and lungs are placed in a cage of bones (the ribs) so that they may do their work without being molested. The large arteries which carry the life-saving blood, usually, are placed under the shelter of bones so they will not be easily cut into or broken apart.

The spinal cord, that wonderful branch of the brain which controls, without our conscious knowledge, thousands of important operations of the body, is placed within a tunnel hollowed out of many solid bones which work easily upon one another without injury to the delicate organ within. This column of bones is known as the spinal column.

Fig. 13.—The long bone (femur) of the thigh. Note its large ends. The upper end is round and unites with the hip bone with a "ball and socket" joint. Its lower end makes a hinge-joint at the knee.

Kinds of Bones as to Shape. When the numberless activities of the body are considered, it is evident there

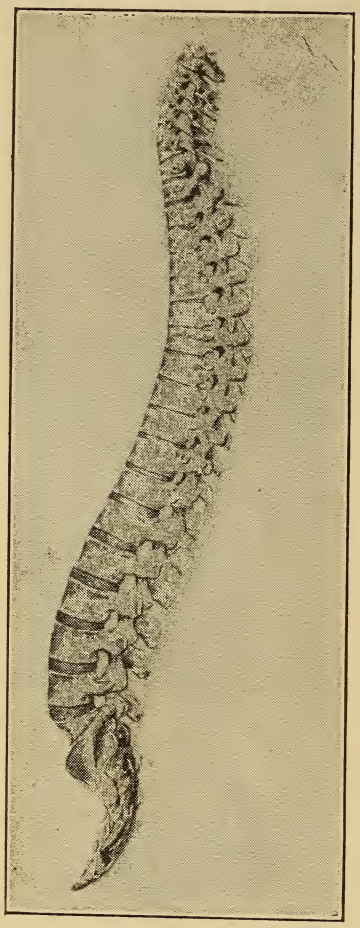


Fig. 14.—The spinal column through the hollow of which runs the spinal cord.

must be bones of various sizes, shapes, and lengths.

There are flat bones for protecting delicate organs and furnishing a broad base for the attachment of muscles; for example, the shoulder blades and bones of the skull.

There are short, thick bones for strength to support the body, as the bones of the foot; long heavy bones for speed and strength, as the bones of the arm and thigh; short slender bones for speed and delicate operations, as the bones of the fingers; long slender bones for protection of delicate organs and muscular attachment, as the ribs which with part of the spinal column and the breast bone (the sternum) form the chest. Some bones are irregular in shape, as the bones of the spinal column.

The bones of the body, about two hundred and six in number, are arranged to give the greatest usefulness and strength with least bulk and weight. To give

strength and as little weight as possible, many bones are hollow for almost their entire length.

The longer bones of the limbs are so constructed. If a piece of paper be rolled into a hollow cylinder and each end set upon a block, it will require considerable force to

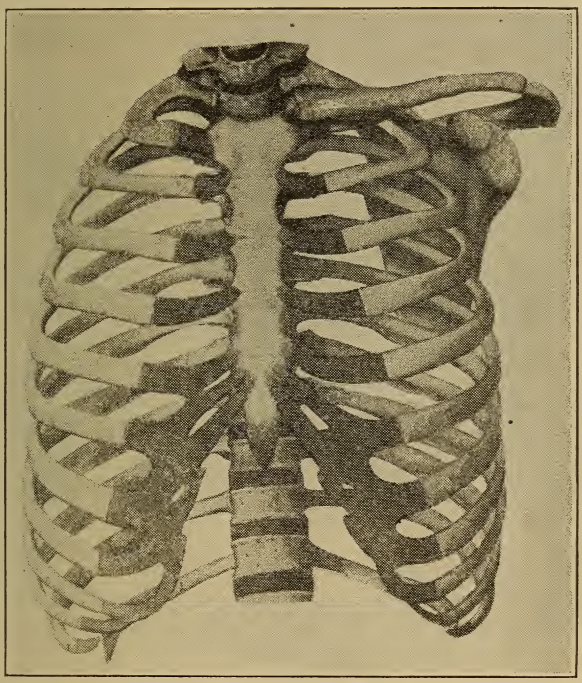


Fig. 15.—The chest or "bony cage" for the attachment of muscles, and protection of delicate organs (lungs, heart, liver).

break it. The same amount of paper made into a solid piece would be far less strong.

If a bar of iron as long as a piece of hollow pipe and weighing just as much is placed upon two supports, it will be found that the cylinder of iron will support without bending much more weight than the solid bar.

If the bones of the arm or leg, for example, were one solid piece of bone and weighed no more than they now do, they would break very easily and would hardly support the weight of the body. If they were solid and large enough to support the body, they would be so large they would make it look clumsy and produce slow and awkward movements.

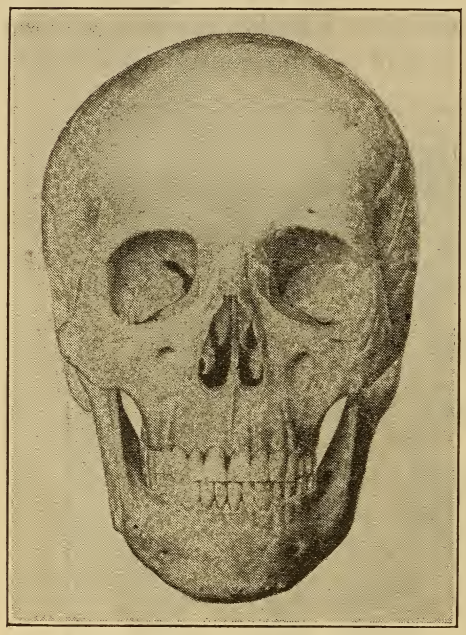


Fig. 16.—The bones of the head and face. Observe the bony sockets to protect the eye-balls.

Joints. To support the body all its bones must be joined together. Some bones have no motion at their joints which are called **immovable joints**; for example, the bones which form the skull.

Many bones move freely upon one another by means of **movable** joints. When motion is in two directions only, the bones work upon one another by means of the **hinge** joint. When motion is required in all directions a **ball and socket** joint is used. Where there is a great variety of movement required, as in the wrist, a **compound** joint is employed.

Bones near the joints are made larger so that the muscles can act with greater power in moving the bones.

If the bones were the same size all the way up to the joint, much of the power would be lost in pulling the bones together. Take two sticks with square ends and lay them on the table end to end. Fasten a string close to one side and bring it straight down the side to the end of the other stick. Pull the string in this straight line and note how hard a pull it takes to break the joint.

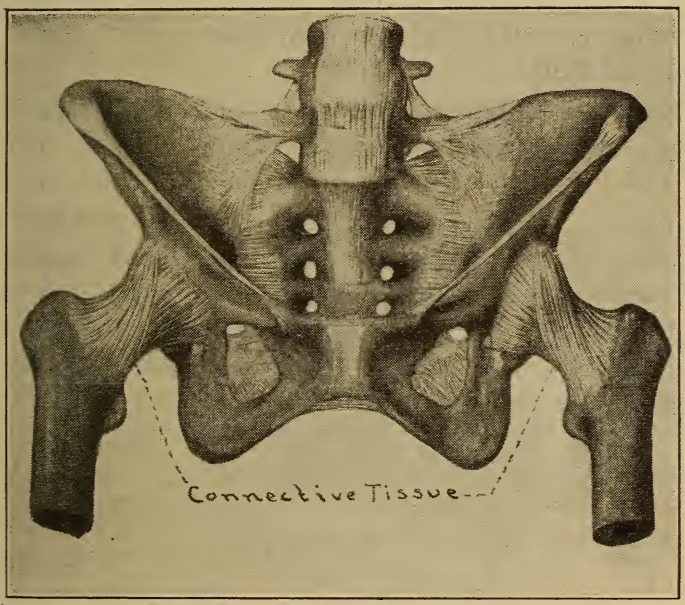


Fig. 17.—The bones of the hip (the pelvis). Note the strong bands of connective tissue holding the bones together.

Place a piece of chalk near the joint under the string and pull the string as before and see if the joint breaks easier.

The **tendons** which are the tough cords forming ends of the muscles, work over these enlargements and do the work of the muscles with greater ease. Bones are covered

with a tough glistening membrane called **periosteum** which is inelastic.

Between the joints, cartilage is placed to serve as pads or cushions to prevent jarring when the body is in motion. These pads of cartilage are covered with a **synovial** membrane.

To prevent friction and insure a smooth, noiseless working of the bones the synovial membrane and the tendons working over the joints are kept lubricated, "oiled," by **synovial fluid.**

Structure of Bones. In early childhood the bones are much more soft and spongy than in later years. This is a wise provision of nature to protect the child, for the bones being spongy will not break as easily as if they were hard and brittle like a piece of chalk. In old age a slight fall will often cause a serious break in a bone because the **animal matter** which gives to the bone its elasticity in youth has largely disappeared and it is composed mostly of **mineral matter** which is hard and brittle. If a fresh bone is put into a grate of live coals for an hour, the animal matter will be consumed and the bone will consist of mineral matter when it may be easily crushed like chalk.

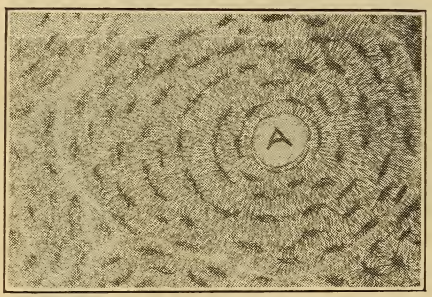


Fig. 18.—A thin slice of bone greatly magnified showing the canals and passages for the nerves and blood vessels. A. Haversian canal.

If a bone be soaked for several days in strong vinegar or diluted muriatic acid, the mineral matter will be re-

moved and the bone may be bent or even tied in a knot because it contains mostly the animal matter.

A bone when sawed across is seen to be hollow and to contain fat which is called marrow. Blood vessels and nerves are also found in bone marrow. It is found to be spongy and filled with tiny holes. These are the mouths of the **Haversian Canals** which in health allow blood vessels and nerves to reach every part of a bone.

If a thin piece of bone not larger than the head of a pin be put under the microscope, these tiny canals may be seen and even smaller ones branching out to feed the bone cells of which every bone is composed.

Summary

Giving to the body its shape and support, protecting delicate organs, and serving as levers for the action of muscles, comprise the three most important uses of the skeleton.

Bones are short, long, flat or irregular according to the use for which they are intended. Some are for strength and speed, some for attachment of muscles and supporting weight, some for protecting delicate organs and some for speed and dexterity.

Many bones are hollow to give the greatest strength with least weight.

Joints are either movable or immovable and enable the parts of the body to bend and move about. Without movable joints the human body would be stiff like a tree. The hinge, ball and socket and compound or gliding joint give to the body all its motions.

The jarring of the body is prevented by cartilage being placed between the bones, and by the use of curves in the erection of the skeleton.

Bones are composed of animal and mineral matter, and

these are responsible for the difference in hardness of the bones of the young and old.

Bones are nourished by blood which reaches the cells through the blood vessels in the marrow and canals.

Questions

1. What are the uses of the bones of which the skeleton is composed?
2. What would happen to your body if by some means your bones could be suddenly removed? Would your head feel hard? Why? How tall would you be?
3. What kind of bones are there as to shape?
4. Why are the bones of the foot short and thick? Why are the bones of the arm and leg long and strong?
5. Why are some bones hollow? Why is a wheat straw hollow? Why do men use hollow steel tubes in building bicycles?
6. What are joints? Why are joints?
7. What are movable joints? Immovable joints?
8. How many kinds of movable joints are there?
9. Give an example of each.
10. Why are bones made larger near the movable joints? How can you prove this?
11. What are tendons?
12. What is cartilage for? Where is it found?
13. What is the periosteum? The synovial membrane?
14. What keeps the joints from "screaking" and wearing when they move?
15. Why should the bones of children be soft?
16. What gives hardness to bones? Why do the bones of an aged man break easier than a child's?
17. Does blood flow through every part of a bone? How?
18. How are bone cells fed? Can the bone cells be seen with the naked eye?

CHAPTER VII

HYGIENE OF THE OSSEOUS SYSTEM

Care of the Bones. Bones require food which contains sufficient mineral matters, lime, salts, and phosphates. These are found in a general vegetable diet. Nursing infants who ought not to eat such things find these salts in their milk, if the mother selects the food which contain a large per cent of mineral salts. These will be discussed in the chapter on Food and Digestion.

When a baby receives too little bone food, a disease called **rickets** is likely to develop and careful attention to diet under the direction of a skilled physician is necessary.

Bow-legs are often caused by eating too little bone-building food. It is often caused by encouraging very young children to stand on their feet too much while the bones are soft and pliable. Nature will usually put a child on its feet when the proper time comes and it is no special mark of distinction to have the child walking with bent legs earlier than other babies whose legs will be straight, if treated properly.

Dislocations. A bone is sometimes thrown "out of joint" or dislocated by falls, blows, etc., and sometimes by the strong action of the muscles. It causes instant pain over the joint and the joint will not work in its usual way. The head of the bone can be felt out of its proper place and the ligaments are usually torn. When it is put in place, the joint, if a large one, should be kept at rest until the "soreness" disappears and then used carefully for a few weeks.

It is always best to send for a physician to reduce the dislocation, for many joints have been badly injured by

ignorant but well-meaning people trying to put the bone back into its place.

Sprains. When a joint is severely twisted the ligaments are sometimes torn or broken loose but the bones may not be thrown out of place. This is exceedingly painful. Until the physician arrives, the part may be placed in hot water, which will prevent too great a swelling. Cold water will sometimes be helpful, or both hot and cold may be used at different times. If the joint may be suitably strapped or bandaged, the resultant swelling and pain are much less and early use of the joint be had. Sprains may keep one on canes and crutches for weeks without this kind of treatment, but with it one may be able to resume his duties in a few days.

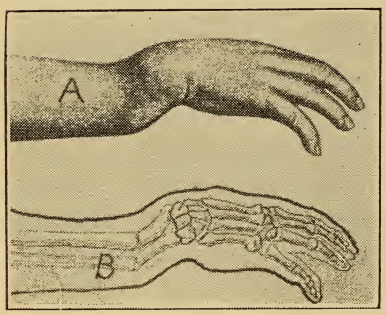


Fig. 19.—A broken "wrist." A. Showing how the hand looks with such a fracture. B. Showing the reason for the deformity.

Fractures. A bone when broken is said to be fractured. This may be done by falling, jumping, blows, muscular effort, crushing injuries, etc. There is always pain and loss of power to move the part. Often, if in a limb, the member seems to have an extra joint which marks the place of injury. The broken bone must not be moved about as the

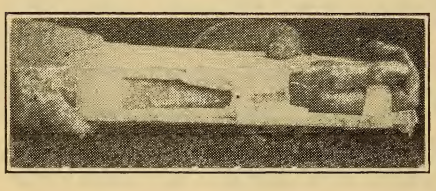


Fig. 20.—The proper way to splint the broken bones as shown in Fig. 19.

sharp edges might cut the nerves or blood vessels. A competent physician should be called at once, and the bone kept at rest until he arrives. The bone when set should remain at rest for several weeks until nature has made new bone cells to take the place of those destroyed, and the broken ends are united.

Stooped Shoulders. This condition is caused by sitting, standing or sleeping so that the bones of the spinal column are kept bent forward in an unnatural position for a long time. The pads (cartiliages) between the bones become thinner on the inner side and thicker behind so that the bones are wedged in this position. It is a deformity that can be easily avoided by sitting and standing in an upright position and by sleeping with just enough pillows under the head to keep the head on a line with the body when lying on the side.

Stooped shoulders cause the chest to become shallow and prevent the lungs from getting a full supply of air. Besides, it looks bad to see a young man or girl with shoulders stooped when by a little effort their carriage may become as erect as anybody's. It may be overcome by constant attention to see that the sitting and standing positions are correct; that is, the shoulders should be held up and the back straightened.

Deep breathing should be practiced several times daily, especially upon getting up in the morning. This is done by standing in an erect position with heels together and slowly breathing through the nose into the lungs all the fresh air possible and then allowing it to escape slowly through the nose. This should be repeated about twelve times a minute for five or ten minutes. This exercise done several times a day by all the pupils in school, with the windows and doors all open will drive away many a

headache and give a brain, poisoned with bad air, new power to do its work.

Bone Felons. This is caused by one of the cell enemies, bacteria or germs. These tiny plants get under the periosteum and begin to grow and destroy bone cells. Felons usually occur on the fingers because they handle many things which contain the germs that get to the bone. The part swells, gets very red, is extremely painful and is considerably warmer than the rest of the body.

Immersing the finger in hot water may relieve the pain some but the best treatment will be given by the physician who, with a clean lance, will cut through the tough periosteum and allow the accumulated matter (pus and blood) to escape. The relief comes almost instantly. If this is not done, a joint or entire finger may be lost or blood poison may develop and the intense suffering will continue for days and sometimes weeks.

Other Bone Diseases Caused by Germs. Inflammation of bones (osteomyelitis) is a severe infection caused by the growth of the common pus germs, and may cause death or loss of an arm or leg or other parts unless the surgeon cuts into the bone and makes a place for these germs and their poisons to drain out.

White Swelling is an inflammation of the bones caused by the germ of consumption. It is a very serious condition and requires the attention of the physician.

Pott's Disease is an inflammation of the bones of the spinal column and is caused by the growth in them of the germ of tuberculosis (consumption). This germ causes parts of the bones to be destroyed so that the common condition known as "hump back" results.

It is a common saying that such a condition was

caused by a fall or other injury. In all cases it is a tuberculosis of the bone which often heals entirely, if the child or person is placed in the hands of a competent physician when the little knot first appears along the chain of bones of the spinal column. The patient will be placed in a jacket to hold the back stiff, at rest and in place. Such a child, when treated properly, will likely be saved from having a humped back.

Summary

Our food should contain enough mineral matter to make the bones hard. Vegetables contain a good quantity of mineral salts. Nursing mothers should eat plenty of bone building food so that the baby may receive sufficient mineral matter in its milk.

Rickets in children is caused by a lack of mineral matter in the food for the bones.

Bow-legs are caused by the child being allowed to stand upon its feet before there is enough mineral matter in the bones to keep them stiff.

A bone "out of joint" is said to be dislocated and should be promptly reduced and treated by a physician.

A broken bone is said to be fractured. It should not be moved about and must be "set" and cared for afterwards by a competent physician.

A torn or detached ligament is called a sprain. Hot or cold water relieves the pain and proper strapping and bandaging by a physician will greatly shorten the time for recovery and relieve the pain.

Stooped shoulders are a result of a bad habit and may be corrected by proper attention to the sitting, standing and sleeping position.

Bone felons are caused by germs growing under the periosteum. The treatment consists in making a drainage by having the doctor cut through the periosteum with a lance.

White swelling and Pott's disease are inflammation of the bone caused by the growth in it of the germ of tuberculosis.

Questions

1. What kind of food do bones require? What food material contains a great deal of bone-building food?
2. What special food should a mother, who is nursing a baby, eat? Why?
3. What is rickets? What is necessary to correct such a condition?
4. What is the cause of bow-legs? How is such a condition prevented?
5. When is a bone dislocated? How may it occur? How should it be treated?
6. What is a sprain? What is the treatment? What is the advantage of having a physician properly strap and bandage a badly sprained joint?
7. What is a fracture? What precaution is necessary to keep from injuring blood vessels and nerves?
8. How does a fracture heal?
9. What are the causes of stooped shoulders? How can one avoid being stooped?
10. What are the disadvantages of stooped shoulders?
11. How should one breathe to develop an erect figure and supply pure air for the body?
12. What is a bone felon? What is the cause of it? What is the best treatment? What is the purpose of such treatment?
13. What is white swelling?
14. What is Pott's disease of the spine?

CHAPTER VIII

THE MUSCULAR SYSTEM

Power of Locomotion. One remarkable difference between animals and plants is the power of the former to move themselves about, or the power of locomotion. A tree when planted must remain in the same spot for years its only movement being from its power to grow larger and taller.

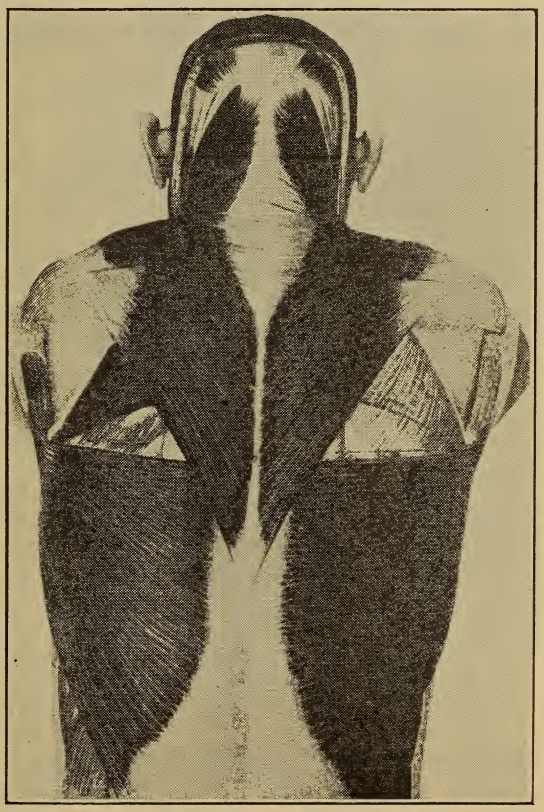


Fig. 21.—Some of the muscles of the back and neck.

An animal may change its location of its own accord many times daily or move parts of itself thousands of times. This power of animals to move is furnished by its muscles.

The lean or red meat of animals is its muscles. When such meat is thoroughly boiled it may be torn into strings or shreds which are called fibers. These fibers are joined together by connective tissue which unites at the end to form the tendon.

Connective Tissue. This is a name applied to the inelastic tissue which is used for binding every part of the body together. It is found everywhere in the body and so finely does it penetrate it that if by magic, the bones, muscles and all of the other tissues could be withdrawn leaving connective tissue alone there would be left a perfect mould for every muscle, bone and organ. A **scar,** after an injury to the soft part of the body, is a collection of connective tissue cells that nature has used to fill up the gap. The stiffness in a joint after rheumatism is caused by the growth of this tissue in the parts which were inflamed. It is one of the supporting tissues of the body and is found most abundant in all the tendons, ligaments, and sheaths of the body which are used to bind the various parts together.

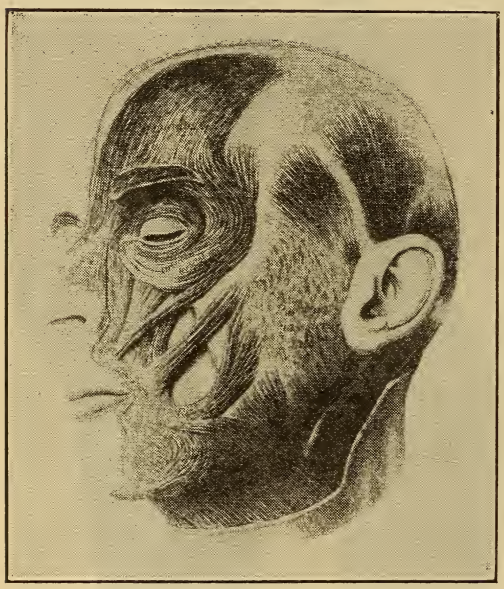


Fig. 22.—Showing some of the muscles of the head and face.

The Muscles and Their Functions. There are more than five hundred muscles in the body making up about one-third of the weight of the body. There are many shapes of muscles to serve their various purposes. The chief function of muscles is to produce motion.

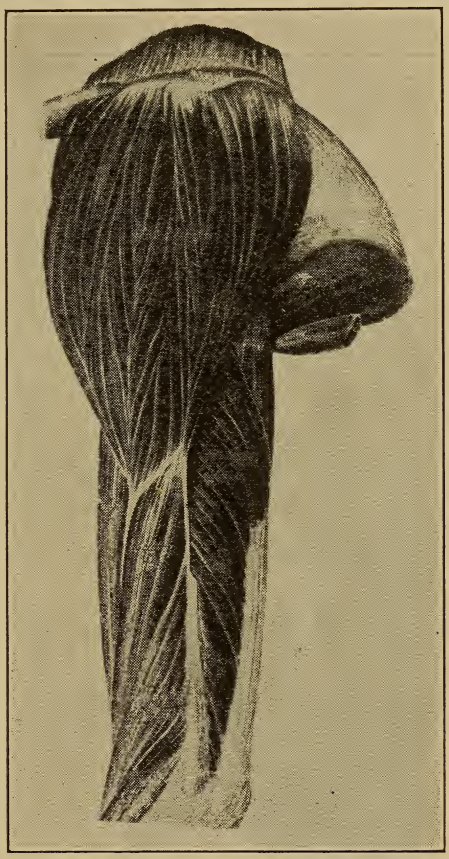


Fig. 23.—(Voluntary) muscles of the shoulder and arm.

Many muscles are used in standing or walking, writing, or talking. It is by action of muscles that blood is pumped through the body or that air is breathed into the lungs. A second value of the muscles is to help protect the delicate organs. Large blood vessels are usually protected by a deep covering of muscles, and the stomach, liver, kidneys and intestines are inclosed in a cavity which is protected largely by strong muscles. Thus they aid the bones in protecting delicate organs.

A third use of the muscles is to help support the skeleton or framework by binding its joints together. Muscles which move the limbs, back, and perform all the movements under our control are fastened to the bones and pass over the joints. Thus they stiffen the bonework and help tendons and ligaments to hold the skeleton in shape.

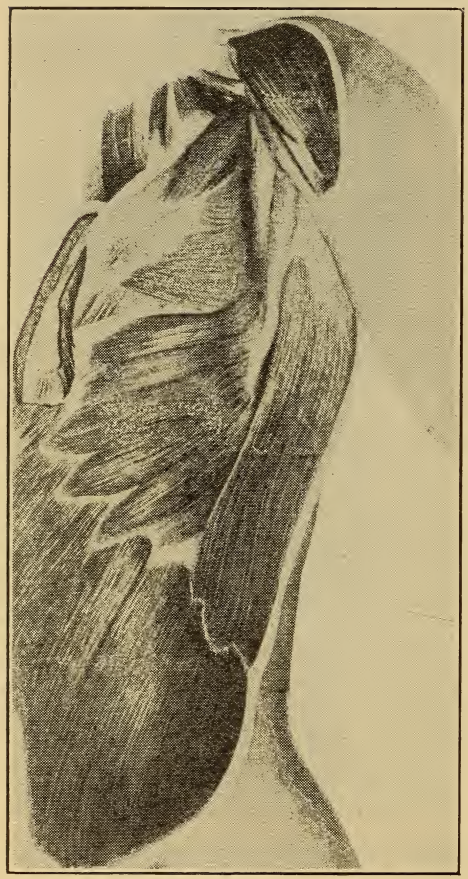


Fig. 24.—Muscles of the chest and abdomen.

In the voluntary muscles, the muscle fibers are very much longer than in the involuntary muscles. We can control many muscles at will. These are the **voluntary** muscles. Should we desire to stand or run or throw a ball, the voluntary muscles required to do this would obey our command. If we should command our heart to stop its beating, it would work just the same. It is an **involuntary** muscle or one over which the will has no control. Some muscles are partly voluntary

and involuntary. We may stop breathing for a short time but in spite of our efforts the muscles will go to work and draw in the air to purify the blood. These muscles, like those which cause the eye to close, are both voluntary and involuntary.

Muscular Sense. We form our judgment of the weight of things by the strength of the muscles required to move them. This muscular sense can be cultivated to a remarkable degree. Grocers can tell by the "feel" of an article about how much it will weigh. We lift a glass of water confident of not spilling it or appearing awkward, for the muscles of the arm have been trained by handling objects of that weight. If the glass were filled with mercury (quicksilver) and the person thought it was filled with water, the muscles would act very awkwardly because of its greater weight until they become used to the new task. One would not attempt to pick up a toothpick in the same way as he would to pick up a bar of iron. The muscles, trained to their tasks, would prepare themselves almost without our knowledge for the greater effort. We use this muscular sense a great many times every day in standing, walking, running, throwing and in every voluntary movement we make. The muscles are balanced and trained to act smoothly and gracefully because of a trained muscular sense.

Attachment of Muscles. Muscles do their work by contracting, or becoming shorter and thicker. If salt be sprinkled upon the skinned leg of a frog, recently killed, the muscles will be seen to contract as if the animal were alive. When the elbow is bent in raising the forearm the large muscle (**biceps**) of the arm contracts and the ends of the muscle come closer together. Its power would be lost if each end were not fastened. The places where

muscles are fastened are called points of attachment. The most fixed point, or the place a muscle pulls from, is its **origin.** The most movable end is its **insertion.** The origin and insertion of all the voluntary muscles are points usually on the skeleton. The biceps like nearly all of the muscles of its kind is larger towards the middle and tapers down to a firm, hard, slender band. This band is the tendon or "leader" as it is often called. Who has not pulled the "leaders" of a chicken or turkey's foot to make the toes bend and straighten? These strong cords are made up of the connective tissue which bind the muscle fibers together, and keep the part near the joint from being large and clumsy.

Fig. 25.—Muscles of the lower leg and foot.

The tendons pass over the joints occupying very little space, and are attached firmly to the periosteum and the bone. The bones at the joint are made larger, as we learned previously, so that the muscle in contracting may lose none of its force in pulling the joints closer together.

Arrangement of Muscles. Muscles are usually arranged in pairs and oppose one another. Thus the biceps bends the arm at the elbow and its opponent, the **triceps,** straightens it. One muscle will close the eyelid and another open it; muscles pull the foot forward while their opponents will draw it back.

Muscles at rest evenly balance one another yet there is just a little pull of each all the time. This is proven when a tendon is cut through. A gap will appear between the cut ends and a great deal of usefulness of that muscle may be lost if the ends do not grow together. A young lady once accidently cut the tendon of the muscle which raised the little finger. Her career in music was stopped because the tendon did not grow together again and that finger could not be lifted from the keys quick enough to perform well upon the piano.

Training of Muscles. Babies have very little control of their muscles. After a few months the muscles have been taught to reach out and grasp things, to move the legs and arms in crawling, and finally to stand alone and walk. The muscles which control the voice, at first could only produce the cry of babies. After much training they begin to use the organs of speech, to say a few words and gradually learn to talk.

After a few years the muscles may be trained to do very difficult and wonderful things; to throw a ball accurately, to write rapidly and plainly, to plow, to play a piano, violin or other musical instruments, to sing, to operate a typewriter, to do skilled work in the factory, to perform delicate surgical operations, and a great many other things which are seen and done so often that we seldom appreciate the wonderful work which the body as a machine performs.

Muscle Wear and Repair. The muscle cells like other parts of the body are being worn out every hour of the day. In health these dead cells are renewed promptly and the muscles are as good and even stronger than before. Every time we walk, run, or move there is damage done to the muscle cells; but the loss of these cells only adds to our health if we know how to live so the worn out cells are replaced by new and better ones. The muscle by exercise becomes redder, firmer and stronger. Feel the arm of a small child and see how flabby it is; then feel the arm of one who does hard labor or who exercises his muscles a great deal and see how hard the muscles feel and how strong they are. Such a person is in a position to enjoy the best of health if he obeys other laws of health as well, does not drink liquors, or lead a dissolute life or in other ways weaken and poison his body.

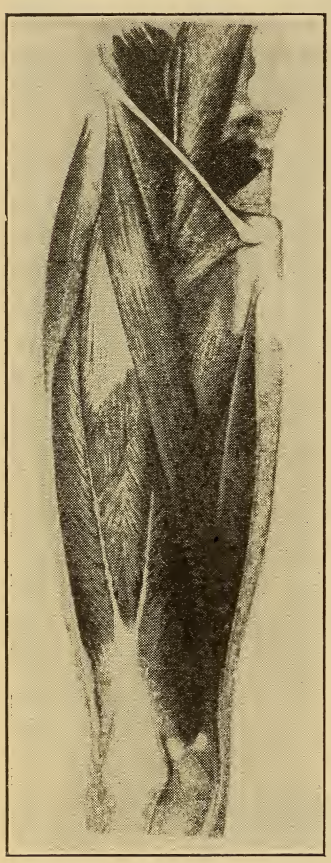


Fig. 26.—Muscles of the thigh

Summary

The distinguishing difference of animals and plants is the power of locomotion of the former by means of muscles.

Muscles are the "lean meat" of an animal and are made up of bundles of fibers bound together by connective tissues.

Connective tissue is one of the supporting tissues of the body and is found throughout its structure.

The muscles number about five hundred and are of various shapes to serve various purposes. Muscles have the three main uses of producing motion, protecting delicate organs, and supporting the skeleton and giving shape to the body.

Muscles are made up of cells which are bound together by connective tissue into bundles of cells or fibers.

A tendon is a collection into one cord of all the bands of connective tissue which binds the bundles of fibers of a muscle together.

Muscles are either voluntary or involuntary, depending upon the ability of the will to operate them.

A muscular sense is the result of training the muscles to act promptly and certainly when performing the many operations of our body.

Muscles produce motion by their power of contractility, acting from the point of origin upon their point of insertion. The tendons of voluntary muscles pass over the joints of the skeleton and are fastened firmly to the bone of the part to be moved.

Muscles usually act in pairs, one opposing the other.

Tendons enable muscles to transfer their power past a joint without increasing its size.

Muscles in infancy work very imperfectly but become trained and expert in their work with advancing years.

The cells of muscles are worn out with use but in health are replaced at once with new ones and become stronger than before. The muscles of one who uses them a great deal, a farmer, blacksmith, or an athlete, are hard, red, and strong because of their use. The muscles of one who uses them little are pale, flabby and weak because they have not been used enough.

Questions

1. What is meant by locomotion as applied to an animal?
2. What is "lean meat"? Of what is it composed?
3. What is connective tissue? Where is it found? What are its functions?
4. What is a "scar"? Why does rheumatism sometimes make one's joints stiff?
5. How many muscles are there?
6. How many chief functions have the muscles? Name them.
7. Give six illustrations of the use of the body to produce motion.
8. Name three examples of the use of muscles to protect delicate organs.
9. Give the structure of a muscle.
10. What are voluntary and involuntary muscles? Give examples of each.
11. What is meant by muscular sense? Give some illustrations of the use of muscular sense? What is meant by a person being awkward?
12. How do muscles move the body? Why are both ends fastened?

13. What is the origin of a muscle? Insertion?

14. What is a "leader"? Of what is it composed? What is the use of a tendon?

15. How are muscles arranged to do their work? Why are they arranged thus? How is it known that muscles "pull" against one another?

16. At what time in life are muscles untrained? What is meant by training muscles? Give ten illustrations of the work of trained muscles.

17. How do muscles wear out? How are they repaired? What strengthens a muscle? Name three ways muscles may be weakened.

18. What is the difference between the muscles of one who uses them a great deal and one who does not? Other things being equal, which will have the best health and accomplish more?

CHAPTER IX

HYGIENE OF THE MUSCULAR SYSTEM

Exercise. Muscles grow in strength by exercise. A much used muscle is a strong muscle. It is larger, firmer and redder than an unused muscle. The lean meat of a hen's breast is the muscles of flight, and because she flies very little the breast meat is pale or white. The breast of a pigeon or wild duck or guinea is dark in color and much firmer because of the exercise of those muscles in flight.

Fig. 27.—An athlete. Running is only part of his muscle training.

Exercise is helpful because the action of the muscles causes the blood to flow freely and makes us breathe more air into the lungs; the body cells take on new life and new force is given to all the organs of the body; our appetite for food is increased and its digestion is better; a tired brain becomes rested and will think more clearly.

Forms of Exercise. Walking is the most usual form of exercise. It brings into action the muscles of the limbs and back and the muscles of the abdomen. It is not sufficient because only certain groups of muscles are used. Running is a more violent form of exercise than walking and brings more muscles into play and, when used in moderation, is one of the most useful forms of exercise. Long endurance races work a great hardship on the heart muscle and do harm to the body instead of good.

One should stop any kind of exercise when there is a feeling of faintness or undue fatigue.

Jumping and Skipping are excellent if not indulged in too long. The muscles of the lower limbs, abdomen, back and arms are used in these exercises.

Horseback Riding is very beneficial because many muscles are brought into action and the pleasure of the ride adds to the benefit from the exercise of the muscles.

Exercise of Occupation. Farming. The person working on a farm gets many forms of exercise that tend to develop all of the muscles uniformly. **Plowing** exercises every muscle of the body. **Hauling, lifting, chopping, mowing, cultivating,** and the many other forms of work on the farm make it the most favorable life for making strong, healthy men and women.

Fortunate is the student who was raised upon a farm and used to outdoor life and work for, everything else being equal, he will be the winner in the race of life over the one who has led a life indoors.

Games. Baseball, basketball, tennis, golf, football are all games which require a great amount of muscular effort and are splendid forms of exercise.

When to Exercise. Those who lead the life of a student or a sedentary life should have a regular time each day to exercise; before breakfast, an hour before meals, and light exercise before retiring. Violent exercise should not be indulged in immediately after a meal because it causes the blood to flow away from the organs of digestion where it is needed to digest the food.

Muscle Enemies. Too little exercise will cause weak muscles. The body will not receive enough fresh air, food will not be relished or digested so well. The poisons of the body will not be thrown off by the skin, kidneys,

or bowels; the blood will fail to repair the body cells so well and the brain will work slower. All these bad conditions will impair the usefulness of a person and finally make one ill or shorten his life.

There is a direct relation between muscular exercise and brain efficiency; the brain workers will do their work best and longest with less fatigue when they exercise freely and properly.

Tobacco and Alcohol. These poisons make muscle cells weaker and hinder their repair. The heart muscle is so affected by the use of tobacco that after a few months or years it fails to beat regularly and often flutters as if it would stop. This makes a condition known as a "tobacco heart." The body muscles at work become tired quicker than muscles which have not been poisoned by these drugs. In severe sickness when all the strength of the body is needed to win the fight, the person who is not addicted to the use of tobacco or alcohol is most likely to recover. In pneumonia and typhoid fever, where all the strength of the body is needed to get well, the death rate of persons who have poisoned their body with alcohol or tobacco is much higher than in people whose muscles and body are free from their effects. Trainers and athletes know this is true and prohibit the use of tobacco and alcohol, when a team is training for a contest where prolonged muscular effort and strong bodies are needed to win.

An Erect Figure. The erect position of the body is kept by the action of the muscles along the spinal column. A stooping position results in a pressure upon the lungs and heart because the bones are not supported by the muscles in their natural position. If a stooped position is continued throughout childhood, the muscles will grow to fit a bent body instead of a straight one, and such a

person will be more or less deformed throughout his lifetime. In early years of life one should learn to hold the body erect when sitting, standing, or walking. This is done by stiffening the muscles along the entire back so that the spinal column will take on its graceful curves. The head should be thrown back and the shoulders will naturally take their proper place. It is a mistake to think that by simply pulling the shoulders back one assumes an erect position. After a few weeks of training a person can form the habit of keeping the body erect.

Summary

Muscles develop by exercise, becoming tougher, redder and stronger.

Exercise is a cell builder for the whole body because more air is supplied to it, more food is eaten and digested better, and poisons of the body are thrown off more easily.

Walking, running, outdoor games, horseback riding, and certain occupations that require muscular effort are the best forms of exercise.

Persons living indoor lives should take a certain amount of exercise each day in order to keep the body in health.

Too little exercise will result in ill health, reduced efficiency or a shorter life and less enjoyment. The best brain workers and the most efficient men are those who keep their bodies healthy by exercise.

Tobacco and alcohol are muscle enemies because they poison muscle cells and all the other body cells and make them weaker. This is shown by a larger number of peo-

ple dying from dangerous diseases who have been users of tobacco and alcohol.

An erect position can only be had by forming the habit of straightening the spinal column when sitting, standing, or walking.

Questions

1. What is meant by muscular exercise? What effect does it have on muscles? Why is the meat of some animals white or pale? Why red and dark?

2. State seven reasons as to why exercise is helpful.

3. Name ten common forms of exercise of children and adults.

4. Why is walking not sufficient exercise? Is running or jumping better? Why?

5. Why are horseback riding, tennis, baseball, football, and golf fine exercise for muscles?

6. What is better exercise than that of farm work? Why? Name four other occupations you know about which furnish plenty of muscular exercise.

7. What is the advantage of a splendid muscular development over a poorly developed muscular system? Why?

8. Do people who have strong muscles necessarily have great brain power? Why? What is the advantage, then, of having plenty of exercise?

9. Name three muscle enemies. Why is too little exercise injurious? Give five reasons.

10. How do tobacco and alcohol affect muscle cells? Do they affect body cells? How? What happens often to the heart muscle after use of these poisons?

11. Why do chronic drinkers and tobacco users die more frequently from typhoid fever and pneumonia or other dangerous diseases than those who do not use them?

12. Are drinkers of whiskey, beer, or other alcoholics and users of tobacco chosen for athletic events? Why?

13. How is an erect figure maintained? Why do some people have stooped-shoulders all their lives? Why is it necessary to train the body in an erect position in childhood?

CHAPTER X

THE DIGESTIVE SYSTEM

In the preceding chapters we have studied the framework of the body; its muscles, its power to move, repair itself, to fight its battles, and many of its operations. The question naturally arises, what produces all this power?

Any machine to do things must have force and energy. A clock runs because of the force of its spring or weights. An automobile engine pulls its weight because of the power in its steam or in the explosions of gas within the cylinders; a steam engine draws its immense burdens because of the energy stored up in coal which when burned under the boiler containing water, produces steam; a horse is powerful because of the energy which it receives from hay, oats, corn, or other food; and the human body to do all its work must be supplied with energy or force. This it receives from the food. The method of changing food into skin, bones, muscles, blood, brain, fat, etc., is one of the most interesting and wonderful things in all the world.

Today on the dining table will be bread, meat, milk, and vegetables; tomorrow these will be changed into a blood cell, bone cell, brain cell, or some other part of the body, and its force will be used to walk, work, write, play, sing, produce beautiful music, or think, to bat an eye, swim, take a delicate stitch, or lift a heavy burden, and presently we shall be hungry again for food to supply energy for other tasks.

This change of food into flesh is the result of **chemical action.**

Chemistry. To have a practical knowledge of the kind of food to eat, its preparation and quantity, it is necessary to know something of the composition of matter or the materials which make up the world. Chemistry is the science which investigates the composition of all substances together with the changes resulting from their action upon one another under the influence of chemical force.

Light a match and watch the wood burn; the wood burns because of the chemical action of the oxygen of the air upon the wood which was once a part of a living plant. Coal burns because of the action of oxygen upon the carbon of the coal. The heat is thrown off because of this violent chemical action. Smoke is part of the substance which has not been consumed by the oxygen.

Mix a teaspoonful of soda and vinegar together; notice how it boils (effervesces) and becomes warmer. This is because of the chemical action of the two substances upon one another. Whenever chemical action occurs, heat is produced.

Composition of Matter. Everything of the earth, living or dead, animal, vegetable, or mineral, is composed of about eighty things called **elements.** Think of taking only eighty substances and making hills, the rivers and oceans, the air, the trees, flowers, cities, railroads, the people of all the earth and its millions of animals and plants, everything which we see, feel, hear, taste or smell. What a wonderful architect is God, who did it all!

When two or more of these elements unite with one another they form a **chemical compound** and may be entirely different in appearance, form or nature from the elements composing it. Two parts of hydrogen (a gas)

and one part of oxygen (a gas) form water, the most abundant of all chemical compounds. When one part of carbon (a solid) is united with two parts of oxygen there is formed **carbon dioxide,** which is a gas. Every flame is giving off quantities of this gas. Animals which breathe air into their lungs, throw out of their lungs, with each breath, quantities of this carbon dioxide which has been formed in the body by chemical action.

The most used elements in the making of all things are carbon, oxygen, hydrogen, nitrogen, sulphur, phosphorus, iron, copper, silver, gold, lead, zinc, chlorine, sodium, potassium, platinum.

The air which we breathe is not a chemical compound but is chiefly a mixture of two gases; oxygen, one part, and nitrogen, about four parts. These two gases do not unite with one another very well because they have very little attraction for each other. In chemistry this attraction is called **affinity.** We breath air to get this life-giving oxygen into our blood so that it will produce a chemical action in our body cells. This chemical action produces the heat of our bodies and the poisonous carbon dioxide which is formed in the body cells is thrown out of the body with our breath.

Composition of Vegetable and Animal Matter. Living things like trees, grasses, vegetables, people, horses, fish, birds, etc., are the most complicated of all created things. The elements composing them are combined into many different chemical compounds. A very few chemical elements, however, make up these tissues. Carbon, oxygen, hydrogen, nitrogen, sulphur, and phosphorous make up most of the tissues of living things.

We have learned that body cells are being worn out all the time and new ones in health take their places.

A body cell contains these elements of carbon, hydrogen, nitrogen, oxygen, sulphur, and phosphorous, as do the vegetables, meats, and other foods we eat. When food is digested or acted upon chemically in our organs of digestion, it is ready to be taken up by the blood and carried to every body cell that needs a new cell or requires more energy and power. When food reaches worn out body cells or weakened ones the oxygen which we get by breathing air into our lungs and which is carried also in the blood causes a chemical change to take place between the body cells and the digested food. New cells are made and new force is created as a result of these chemical changes which are going on all the time in our bodies and enough heat is created to keep our bodies warm. A dead animal gets cold because chemical action in the body cells has stopped.

Life by Death. We are in a position now to understand that we live by death. In living creatures around us, cattle, sheep, poultry, fish, and in living plants like corn, wheat, oats, vegetables, there are the necessary chemical elements of carbon, hydrogen, nitrogen, oxygen, sulphur, phosporous and others needed for building up our bodies. We destroy these living things, and after preparing them they are put into our bodies which change them into a suitable form for the blood to carry to starved or worn-out body cells. New cells are formed by chemical action and new life and strength are given to our bodies.

Summary

In performing its various operations, the body, like any other machine, must be supplied with force or energy. This is received from the food we eat and air we breathe.

The process of converting food into flesh, action, and thought, is a most wonderful one and depends upon chemical action.

Chemistry embraces the study of the composition of matter and the changes resulting from the action of parts of matter upon one another under the influence of chemical force.

The burning of wood, coal, or other substances is a chemical action of the oxygen of the air upon the carbon of such materials.

All matter is composed of elements numbering about eighty. Water is a union of two parts of hydrogen and one part of oxygen. Union of chemical elements as a result of chemical force to form new substances forms a chemical compound. A mixture is not a chemical compound. Air is a mixture, largely, of one part oxygen and about four parts nitrogen. Carbon, oxygen, hydrogen, nitrogen, sulphur, phosphorous, iron, copper, silver, gold, lead, zinc, chlorine, sodium, potassium, are the most commonly found elements in nature.

The cells of the human body are composed mostly of carbon, oxygen, hydrogen, nitrogen, sulphur and phosphorous. These elements are found in the food we eat, and by chemical action are changed into new cells, thereby giving to the body its heat and energy.

This chemical action in the body cells is brought about by the oxygen in the air which is carried by the blood to every body cell.

We live by death. The living plants and animals which are used for food when cooked and digested are converted into such chemical compounds that the carbon, oxygen, and the other elements in them are converted into new cells or furnish new energy to those that need it.

Questions

1. What is necessary to make a machine operate? Give five examples of machines and state their source of energy.

2. What supplies the motive force of the human machine? Name several kinds of cells which receive energy from food.

3. What is chemistry? What has it to do with a knowledge of the body? Give three examples of chemical action? What is water? What is air? What is smoke? What is a chemical compound? What is the difference between a mixture and a chemical compound?

4. About how many elements have been discovered? What are elements? Name sixteen of the most commonly found elements. What is chemical affinity?

5. Of what elements are the cells of the body mainly composed? Why do we eat vegetables and meats?

6. Why do we breathe air into the lungs? Why do we breathe air out of our lungs?

7. What is the purpose of having oxygen in our blood?

8. What carries digested food to the body cells? What else does that agent carry to them?

9. What happens when a worn-out or tired body cell, some digested food and some oxygen meet anywhere in a living body? What happens to the cell? What becomes of the food and the oxygen? Is there any relation between what happens here and the burning of a match? Why?

10. Why is the body warm when living? Why cold when dead?

11. Explain what is meant by "living by death."

CHAPTER XI

THE ORGANS OF DIGESTION

The process of digestion takes place within a tube about thirty feet long. This tube commences at the lips and extends through the mouth, esophagus, stomach, and is then coiled about in many folds in the abdomen where

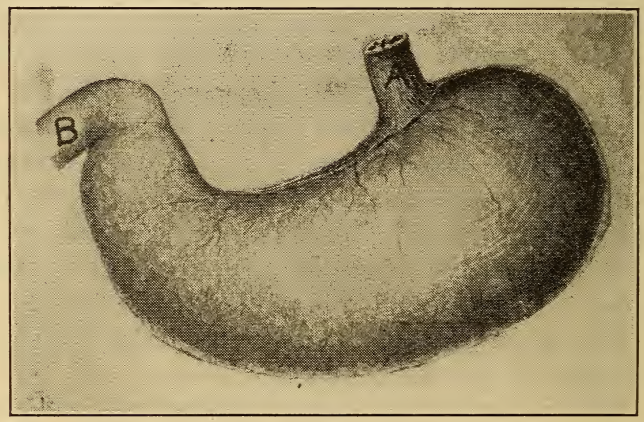


Fig. 28.—The stomach. A. End of the food tube (esophagus) from the mouth. B. Opening into the small intestines.

it is called the **intestines** or bowels. The first twenty feet of this tube in the abdomen, is called the **small intestines** and the last six or eight feet, the **large intestines.** This entire tube is called the **alimentary** canal and is of varying size. The first enlargement is in the mouth, then follows a narrow part, the esophagus, about ten inches long which expands into a pouch. This pouch when full is about twelve inches long and four inches in diameter in an adult and is called the **stomach.** It then passes through a narrow opening, the **pylorus,** into the small

intestine which is about an inch in diameter. The tube remains about the same size until it merges into the larger intestine.

Into this tube are poured at different places a number of juices furnished by **glands.** These digestive juices act chemically on different kinds of food reducing them to a liquid, splitting them up into simpler compounds ready for **absorption.**

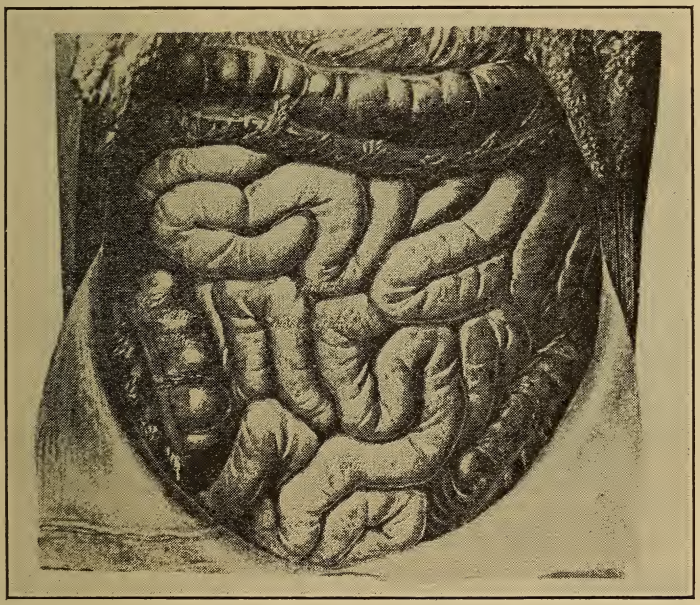


Fig. 29.—The intestines.

The **alimentary tract** or tube is lined throughout with a delicate red membrane, the mucous membrane, and it is supplied with muscles in its wall so that the food is pushed along from place to place by the contraction of these muscles, one layer of which runs around the tube

like a ring, and another lengthwise. In some parts, another layer runs slantingly or obliquely with the tube. When these muscles contract they force the food forward acting much after the manner in which a fishing worm (angle worm) travels. If a mass of food is swallowed, these muscles grasp it just when it has passed back of the throat and pull it downward whether we will or not. Clowns can drink water when standing on their heads for this reason.

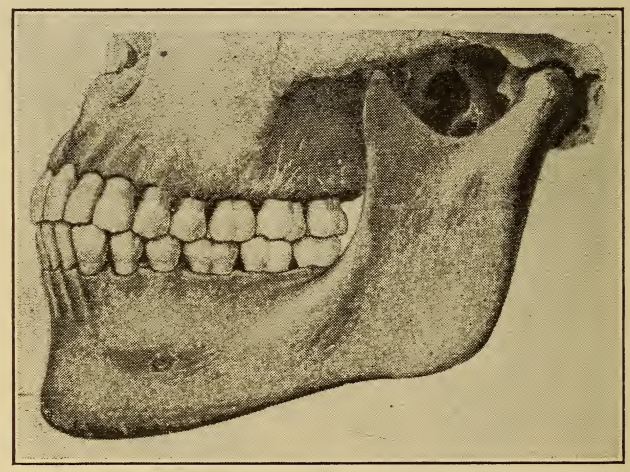


Fig. 30.—The teeth. One of the organs of digestion.

Mastication. The teeth are very important organs of digestion. The muscles of the jaw by contracting cause the lower jaw to crush against the upper one, in both of which are set the teeth. The food is held between these grinding and crushing instruments by the muscles of the tongue and cheeks so that large masses of meat, bread, or other food are ground into fine particles. This process is called **mastication.**

Insalivation. At the same time the teeth are at work there is being poured out of little tubes, which reach back to the **salivary glands,** a fluid which soaks all through the food and makes a pasty or soft mass out of it. It makes the food easier to swallow and by the action of the **ptyalin** which it contains, the starches are partly converted into a form of sugar. This process is called **insalivation.**

The **salivary glands** are six in number; three on each side of the face. One is just in front and below the ear; this is the one which becomes enlarged and painful when a person has **mumps,** and is known as the parotid. Another, the sub-maxillary, is just below the border of the lower jaw and the third, the sub-lingual, is situated below the tongue. These glands manufacture from the blood the **saliva** which contains a **ferment** to convert starches into a form of sugar.

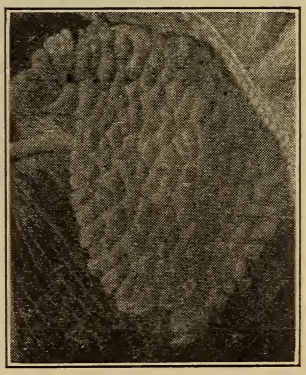


Fig. 31.—One of the salivary glands (the parotid).

A ferment or enzyme is a substance which can cause by its presence a breaking up of certain chemical compounds into simpler ones and yet undergo no change itself.

Gastric Digestion. Arriving in the stomach the food is mixed with **gastric juice** which is secreted by the gastric glands in the stomach wall. This juice contains a ferment called **pepsin** which acts principally upon the proteids. It contains also hydrochloric acid which must be present for the action of the pepsin.

Intestinal Digestion. After the food has reached a proper degree of digestion in the stomach, one end of the stomach opens and the food passes into the small intestines. Here it is mixed with the **bile,** and the **pancreatic** juice which contain three active **enzymes.** One of

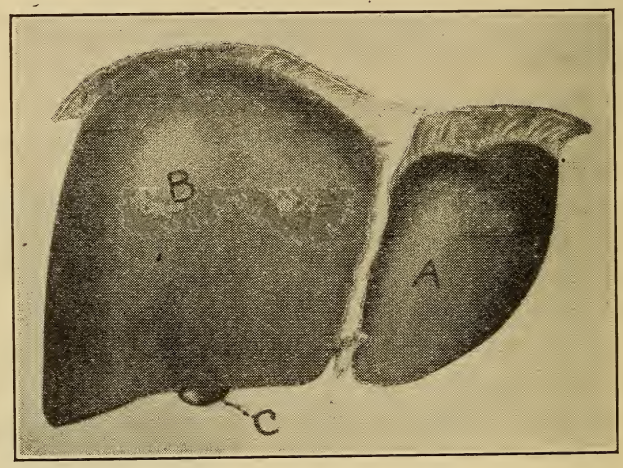


Fig. 22.—The liver. A. and B. "lobes" of the liver. C. The tip of the gall-bladder.

these digests the fat and the other two aid in digesting the starches and the proteids which have escaped the digestive action of the saliva and gastric juice. The bile is not an active digestive agent in itself but by its presence aids the other juices to do their work.

The bile is secreted by the liver which is the largest gland in the body and weighs nearly four pounds. Its cells manufacture the bile (gall) which is stored for use in the **gall bladder.** When the food reaches the intestines this bladder or pouch empties its contents through a tube into the small intestine.

The **pancreatic juice** is secreted by a long, slender gland

back of the stomach and finds its way to the small intestine through a tube which joins the gall bladder tube.

Absorption. Along the course of the small intestine are tiny projections of its lining mucous membrane giving it a velvety appearance. These are called **villi.** These villi absorb or "soak up" the digested food so that it finds its way into the blood stream. All of this digested and absorbed food in the blood now passes through the liver and is finally prepared for use by the body cells. The liver is the great "clearing house" for all the food we eat. Poisonous substances are arrested here and an effort is made to oxidize them or convert them into harmless substances. The liver of a person who drinks beer, whiskey, and other alcoholic beverages frequently becomes greatly enlarged because the liver has overworked itself to stop these poisons before they reach the body cells. If such a person persists in drinking these liquors the overworked liver undergoes a slow inflammation and connective tissue takes the place of worn-out liver cells. This causes the liver to become smaller in size and knotty in appearance when it is called "hob-nailed" liver. Such a person suffers constantly from indigestion and altogether has an unhappy existence.

Fig. 33.—Cirrhosis of the liver ("hob-nailed" liver) from long, continued use of alcoholic liquors.

Assimilation. The process by which the food, digested

and absorbed into the blood stream, is converted into new cells or "flesh" is called **assimilation.**

The food, now properly prepared, is carried to the hungry cells and each cell takes unto itself the particular kind of food needed for its growth or recreation. Thus, bone cells require certain salts as lime, potash, and muscle cells, forms of protein.

Summary

Digestion of food is performed within the alimentary tract which is a tube of varying size about thirty feet long. It is divided into the mouth, esophagus, stomach, small and large intestine. Digestive juices containing ferments or enzymes are poured into this tube at different places to digest certain kinds of foods. It is lined with mucous membrane and supplied with muscles which are used to move the food forward.

The teeth perform a valuable service in digestion by reducing the food to fine particles so that the digestive juices may act upon them to better advantage.

Saliva softens the food and, by the action of ptyalin, converts starch into malt sugar.

The glands of the stomach-wall secrete gastric juice which contains pepsin and hydrochloric acid and digests principally the proteids.

The pancreas secretes the pancreatic juice containing three enzymes which digest fats, proteids, and starches.

The liver secretes bile and receives the blood after food has been absorbed by the villi of the intestines. It stands guard for the body cells and endeavors to stop poisonous materials before they can do harm to the body.

The liver of a drinker of alcoholic beverages often becomes enlarged because of the efforts of the liver to stop these poisons before they reach the body cells. Later, the liver often becomes "hob-nailed."

Questions

1. What is the alimentary canal? How long is it? What are its divisions? What is its function?
2. What is mastication? Where and how is it performed? What is its purpose?
3. What is insalivation? Name two of its purposes. What is the saliva? What produces it? How many salivary glands have we? Where are they located?
4. What is the esophagus? Into what does it empty?
5. How large is the stomach? Why is it made large? What juice is secreted here? What secretes this juice? What does it contain? Why is hydrochloric acid present?
6. What is a ferment? Name two found in the body.
7. Where is the pylorus? What does it do?
8. What juices are found in the intestine? How many enzymes in the pancreatic juice? What is their function?
9. Of what use is the bile? What secretes it? What is the gall bladder? What does it do? What is absorption? Assimilation?
10. How large is the liver? What other important duty has the liver? What does alcohol often do to the liver? Why? What is a "hob-nailed" liver?

CHAPTER XII

KINDS AND QUANTITY OF FOODS

Classes of Foods. Every one's experience shows that many different kinds of foods are eaten in a life time, but examination shows that all such materials are composed of very few **classes** of food stuffs. They are usually divided as follows:

1. Water.
2. Carbohydrates.
3. Fats.
4. Proteids.
5. Mineral Salts.

Water is the most abundant of all materials entering into the formation of the body. It comprises about seventy per cent of the entire body weight and is the agent for liquefying and dissolving various ingredients of the food so that they may be absorbed into the blood stream for use by the body cells. It is found in all foods and tissues and fluids of the body and aids in ridding the body of poisons and wastes.

The Carbohydrates include the starches and sugars. They contain carbon, hydrogen and oxygen but no nitrogen. The hydrogen and oxygen are always so combined in the proportion to form water, i. e., two parts of hydrogen to one of oxygen.

Starches are found abundantly in plant life, chiefly in corn, oats, wheat, barley and other grains, and in potatoes, peas and beans. Starch in the pure state is found in corn-starch.

Sugars are of many kinds and include grape sugar,

cane sugar, beet sugar, maple sugar and malt sugar. Sugar is found in many fruits and is one of the most widely used and best of all foods. They are usually easily digested and are more easily converted in the body into heat and muscular energy. Sugars may also be converted into fat in the body, and thus create a store-house of energy for use in extreme hunger during illness when the surplus and reserve energy of the body are needed to support it.

Fats are found in abundance in both animal and vegetable life. Cotton seed, nuts and olives furnish much fat for use as food. Fats are found in varying quantities in the fat of animals, in milk, butter and lard.

They contain carbon, hydrogen and oxygen but no nitrogen. The hydrogen and oxygen are combined in such proportion that they do not form water. Fats produce much heat and energy when used as food and are more efficient in the production of energy than carbohydrates. In cold climates, fats and oils are largely used as food for this purpose. Persons who perform manual labor usually eat much fat because of the energy it produces in the body.

Proteids. This class of food is absolutely needed to maintain animal life; however, this is not true of the sugar and fats. Proteids are found in animal and vegetable foods. They contain carbon, hydrogen, oxygen, **nitrogen** and, almost always, some sulphur and phosphorus.

The common foods, consisting largely of proteids, are milk and cheese, lean meat, eggs, peas, beans and lentils, oatmeal and wheat.

Proteids are tissue builders more than heat and energy producers in the body. It is this class of foods that is

used to build up new cells to take the place of those worn out and discarded.

Mineral Salts. The bones, teeth and cartilages are the special tissues that require liberal portions of mineral salts for their formation and repair. The principal salts needed are sodium chloride or common salt, and the salts of lime or calcium. Salt is found in every tissue and fluid of the body, but more abundantly in the blood. Other salts needed are the **phosphates, sulphates** and **carbonates** of sodium and potassium and the phosphates and carbonates of **magnesium.**

These salts are found in grains, vegetables, eggs, meat, milk and most of the staple foodstuffs of ordinary diets.

Mixed Foods. Some foods contain all the different classes needed by the body but not in the right proportion. Thus it has been said, "Man can not live by bread alone."

The following analysis of wheat reveals the truth of this statement: Wheat contains 13.6 per cent water, 12.4 proteids, 1.4 fats, 67.9 starch, 2.5 cellulose and 1.8 mineral salts. It is evident that one feeding upon such a food alone would soon die of thirst and certain parts of the body, as the bones and heat-producing cells, would suffer for the lack of the food elements necessary for their construction or repair.

A mixed diet of bread, meat and milk would probably be ample for long periods of time for most people, for such foods contain a sufficient variety and quantity of materials to sustain life in all parts of the body.

Milk has been called the "model food" for it contains in good proportions all classes of foods. Cow's milk contains about 3.5 per cent protein, 3.7 per cent butter (fat), 4.9 per cent **lactose** (sugar) and .7 per cent salts.

Preparation of Foods. Very few foods are eaten raw, among these being certain vegetables, fruits, milk and nuts. Most foods are considered unfit to eat unless they are properly cooked. There are three chief reasons for cooking foods: First, to develop a flavor. Who has not noticed the agreeable odor of a properly cooked steak, and been made hungry by its appetizing flavor? A raw beefsteak is repulsive to the sight and creates no desire for it as a food. Second, cooking makes it easier to digest foods, especially starchy foods. Oatmeal, potatoes, beans and like foods should be thoroughly cooked to break their cells of starch so the digestive juices can reach it. Starch cells have tough enveloping sacs which are softened by cooking. A raw potato is almost impossible to digest, but when well baked, roasted or boiled the starch is freed from its cells and is quite easily digested. Third, cooking removes all danger from infection by disease germs or parasites. Many vegetables are polluted in garden soil by flooding after rains, or by unclean methods of handling or marketing them. Meats are often contaminated by the foul hands of careless dealers. The germs or seed of typhoid fever, dysentery (flux) or tuberculosis may be deposited upon foods when improperly handled. Cooking effectively destroys such germs.

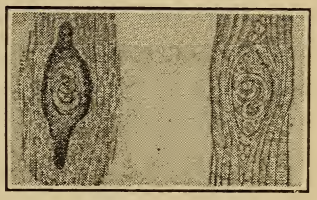


Fig. 34.—Parasites in lean meat.

Pork, beef and mutton sometimes contain small living worms or **parasites.** Pork especially should be thoroughly cooked, to avoid the danger from this source.

Methods of Cooking. There are four methods of cook-

ing: **Boiling, baking, broiling** and **frying.** Boiling is probably the most used and best method of cooking. If a soup or stew is desired, the juices of the meat or vegetables must be set free into the water. For this reason the articles are placed into cold water and heated slowly. If the juices are to be kept in the articles and all the food values retained in them, they should be placed into boiling water. Vegetables should be cooked by placing them in boiling water. Meat placed in boiling water becomes coated over on the outside by coagulation of albuminous substances so that its juices can hardly escape and it may then simmer over the fire for a long enough time to become thoroughly "done." Baking is usually done in a hot oven; roasting, over a fire. In baking or "roasting" meats, the oven should be very hot in the beginning so that a coating is formed over the meat to hold the juices.

Meat is improved in its flavor if, while baking, the juices are poured over it at intervals. Some excellent cooks sprinkle a thin coating of flour over such meat and the paste thus formed which turns to a good brown color, adding to the appearance, helps to keep the meat juices from escaping, thereby adding to the richness of flavor and food value.

Broiling is a favorite method of cooking meats. It is done over a hot fire and the surfaces are at once coated over by the heat and the juices thus kept from escaping.

Frying is a common method of cooking but not so desirable because foods cooked by this method usually become soaked with fats (grease or lard) and are harder to digest. When frying is to be done, the grease into which the foods are placed must be very hot to prevent

the entrance of fat into the foods, and to retain the juices in them.

Serving Foods. Much benefit may be had if foods after being properly cooked, are tastefully and properly served. A good beefsteak, brown biscuit and baked potatoes served hot in clean, white dishes on a table covered with a linen cloth and "set" with glistening glasses and silver, create a greater relish for food and a happier mood for its enjoyment and digestion than the same food served cold in cracked plates on a table covered with "oilcloth" and tin cups.

Summary

Water, carbohydrates, fats, proteids and mineral salts are the chemical classes of food.

Water forms the greater part of the human body and is used as a solvent for foods for body cells.

Carbohydrates consist mainly of the starches and sugars and are abundant in plant life. They are heat and energy makers for the body.

Fats are heat and energy producers and are found as oils both in animal and vegetable life.

Proteids are tissue builders and are found in large amounts in lean meats, beans, peas, cheese and milk.

Mineral salts are needed for special tissues and to promote assimilation. Common salt and lime salts are most abundant in the body.

Mixed foods are needed to supply all classes of foods. Milk is an example of a mixed food.

Foods are usually cooked to make them more easily digestible, to improve their flavor and to kill germs and parasites. There are four methods of cooking foods:

Boiling, baking, broiling and frying. Meats used for making soups are cooked by placing in cold water. Baking or roasting meats add to their flavor and food value. Food properly served is more appetizing and valuable as a food.

Questions

1. What is meant by chemical classification of foods? How many classes are there? Name them.

2. What per cent of the body is water?

3. Name four uses of water in the body? Where is water found in the body?

4. What are carbohydrates? What is their chemical composition?

5. Where are starches found? Sugars?

6. What two uses have sugars and fats when eaten as food?

7. What are fats? Where are they found? What is their chief function?

8. Why are fats used for food in cold climates and by persons who do hard, manual labor?

9. What is the chemical difference between carbohydrates and fats?

10. What are proteids? Name eight foods that contain liberal amounts of proteids? What is their special purpose as a food? Name four foods from animal life that supply proteids? Four from vegetable life?

11. What three tissues require mineral salts? Name six mineral salts? Name the salts most needed in foods? Why?

12. Why can not man "live by bread alone?" What

combination of foods will probably sustain life longest? Why?

13. Why is milk called a "model food?" What is the chemical composition of average cow's milk?

14. What are raw foods? Name six foods sometimes eaten raw? Name three reasons for cooking food? How does cooking improve the flavor of food?

15. Name five starchy foods that should be thoroughly cooked? Explain why? What are starch cells?

16. How may foods become dangerous in spreading disease? What three diseases may be spread by careless handling of foods? What kind of food are subject to such dangers? How can they be made safe for use?

17. What food sometimes contains parasites? What should be done with such foods?

18. Name four methods of cooking? How should meat and vegetables be cooked for making stews or soups? Why? Why are vegetables always cooked by placing them in hot water?

19. Why should meats be placed in a hot oven or over an open flame when "roasted" or broiled? What is the objection to "fried food?" Which can be digested more easily—fried or baked potatoes? Why?

20. Explain the advantage of serving food properly? Make some suggestions to show how foods may be served?

CHAPTER XIII

FOODS

Food Values. Food is the fuel for the body. Next in importance to the selection of the kinds of food for the body's use, is the determination of the quantity of food to be used. This question involves not only the total amount of food and drink required each day, but the quantity of each class of food needed. A meal that supplies the proper quantity of sugars, fats, proteids, and mineral salts is said to be a **balanced ration.**

The rule most of us follow is to eat when we are hungry and what appeals to our appetite. It is a fairly good one, but it leads to many errors. Frequently, too many pickles, too much candy, cake and other sweets are eaten merely because they taste good. This habit results often in impaired digestion and harm to the body. A meal of eggs, meat and beans contains too much protein; one of bread, rice, potatoes and "hominy" contains far too much starch. A balanced ration is, therefore, needed to supply the total quantity of food and of each class.

Food values are determined by a unit of measure, just as the value of United States money is determined by the dollar. This measure is called a **calorie,** and it equals the increase of heat in one pint of water when its temperature is raised 4° F. A boy of twelve requires about 1,200 of calories each day, a woman, 2,500, and a person who does hard labor, about 3,600 units each day. A healthy man usually eats about one-fourth of a pound of dry proteid food each day in addition to sugars and fats that are required to supply his body with energy.

Table of Food Values. The following table gives the quantity of food having a value of one hundred calories:

Cooked or flaked breakfast foods	¾ to 1¼ cups
Milk	⅝ cup (whole)
	1⅛ cups (skim)
Butter, olive oil or any kind of fat	1 tablespoon
Bread, 3 inches by 3½ inches by 1 inch	1 slice
Fresh fruit:	
Large apple or orange	1
Medium banana or bunch of grapes	1
Medium peaches or pears	2
Prunes, medium	4 or 5
Raisins	25
Figs	1½ large
Eggs	1 large
Meat (beef, lamb, mutton, veal, chicken)	2 ounces (about)
Bacon—small thin slices	4
Sugar	2 tablespoons (scant)
Potatoes	1 medium
Macaroni and cheese	½ cup
Rice pudding	½ cup
Ice cream made with thin cream	¼ cup
Cornmeal	3 tablespoons
Hickory nuts, chopped	1 tablespoon
Hominy	2 tablespoons
Honey	1 tablespoon
Olives	7 or 8
Peanut butter	1 tablespoon
Peanuts, 1 cup, 777 calories	
Peas	1 cup
Rice	2 tablespoons
Baking powder biscuits	2 small
Graham crackers	2
Doughnuts	½
Beans, baked	1/3 cup
Lima, fresh	½ cup
Cabbage, dried	⅛ cup
Cabbage, shredded	5 cups
Cucumbers, 7 inches long	2
Radishes, red button	3 dozen

A meal of wheat bread and milk weighing one pound contains about one thousand fuel units of food, or calories.

In selecting the articles of food for a meal not only the various classes of food must be included, but the food value of each article should be considered, and the **total** value in calories or food values furnished.

The above table of food values is useful to assist one in choosing a balanced ration from the standpoint of economy. Cheese and peanut butter have a high proteid value and are usually much cheaper than meats chosen to supply this class of food. A careful study of food values in relation to the market price affords a good opportunity to save money which otherwise may be wasted upon foods which do not have so high a food value.

Alcohol is injurious to the digestive organs. When as much as five per cent of the contents of the stomach is alcohol, it hinders the work of the gastric juice. Its presence in an empty stomach causes a redness or congestion of its lining or **mucous membrane**, and repeated ingestions of alcohol cause a destruction of tissue cells with resulting inefficiency and forms of indigestion.

Its effects upon the liver when its use is continued are marked. The liver becomes enlarged and its ability to make bile and exercise its function of preparing food for assimilation is lessened.

How to Eat. Foods should be eaten at regular periods, with an interval of five to six hours, during which time the stomach and bowels may complete the digestion and absorption of the preceding meal and rest. Solid foods should be chewed thoroughly and well mixed with saliva before swallowing.

Digestion is a complex chemical operation and any interference with it before its completion may result in indigestion or faulty digestion. For this reason, candy,

cakes or other foods should not be eaten between meals. Rest for the stomach is as important as rest for the muscles or brain, and too rapid or too frequent eating or over-eating will result in impaired digestion.

The meal hour should be the happiest period of the day. Good humor, pleasing conversation and freedom from worry or care, promote the secretion of all the digestive juices and thus aid digestion. Worry, fatigue, either mental or physical, sorrow or temper, is a hindrance to the enjoyment and digestion of food.

Loss of Appetite often is caused by too frequent eating or eating too much food or improper kinds of food. Pickles, spices and sweets are often used to stimulate a poor appetite and this leads to further disturbances. Alcohol in beer, wine or whiskey is spoken of sometimes as "appetizers." They should not be used for they create a false desire for food and over-eating with its train of troubles follows.

Patent medicines, many of them containing alcohol or other dangerous drug, are often used by credulous people to relieve indigestion or "stomach trouble." They usually do harm and may lead to the formation of a drug habit.

Summary

The body which makes heat, energy, new tissues and repairs itself needs fuel or food. It needs not only certain kinds of fuel but sufficient amounts of each class of food. Such a meal is a balanced ration, and the whole meal should have a total food value to furnish enough heat and energy but no more. Food values are determined by a unit of measure, called a calorie. A boy of

twelve requires about half the number of calories in a meal as a woman, while a laboring man requires three times as much as a boy.

The food value of any meal may be measured by knowing the amount of the various foods used in the preparation of the meal and the quantity of each food used having a food value of one-hundred calories. For example, four small thin slices of bacon, a piece of bread three inches long, three and one-half inches wide and one inch thick, and one egg would make a meal having a food value of three hundred calories. (See table.)

Many foods having a high caloric value are much cheaper in price and can furnish the body with as much power and heat as other foods which sell for a much higher price.

Alcohol is injurious to the digestive organs. It interferes with the action of the gastric juice in five per cent dilutions. After continued and prolonged use it does a permanent damage to the liver and frequently produces a "hob-nailed" liver.

Questions

1. Why can food for the body be compared to fuel for an engine? Can too much "fuel" be fed to the human body? How do you know this?

2. What is a balanced meal? What else is it called?

3. What makes us eat what and when we do? Is it a good rule to follow? Why?

4. Give an example of a meal with too many starches? Think of another one. Give two examples of a meal with too much protein.

5. Explain what is meant by a calorie? If a quart of

water at sixty-eight degrees F. is heated to seventy-six degrees F., how many calories were needed to do this?

6. How many calories each meal does a boy of twelve need if he eats only three times a day? How many calories would be needed by his mother if she did not perform hard manual labor? By his father if he were doing hard manual work?

7. If a man eat one-fourth of a pound of steak, drinks nearly three cups of milk and eats three slices of bread, each three inches long, three and one-half inches wide and one inch thick, how many calories would be represented in such a meal? Explain. (See table.)

8. Name four foods that can be used to make a balanced ration for a house wife, and show how many calories it would contain to furnish her with the necessary heat and energy.

9. Prepare a menu, or list of foods, for a breakfast for a working man, giving the kinds and amounts of each food needed for a balanced ration. Prepare such a menu for a luncheon or "dinner." A supper.

10. Prepare a menu for supper for a family of five, a mother, the father, two boys, aged ten and twelve, and a girl of eight? What is the total caloric value of the meal? How much of each food must each member of the family eat to furnish the necessary caloric value to supply the body's needs? (See table.)

11. Which is the cheaper for food values, one and one-half pounds of steak at thirty cents a pound or one dozen eggs at thirty-five cents a dozen? Why?

12. How does alcohol injure digestion?

13. What is its effect on the lining of the stomach when used as a beverage?

14. What is its effect upon the liver after continued use?

15. Give two general rules for eating?

16. Why may eating between meals be harmful?

17. What effect has the state of mind during meals on digestion?

18. Give three reasons for loss of appetite? Should alcohol be used in any form to stimulate the appetite? Why?

19. Should patent medicines be used for stomach troubles? Why?

CHAPTER XIV

PRESERVATION OF FOODS

At certain seasons of the year many foods are abundant and cheap and unless some means are employed to store, preserve and keep them, they are wasted. This is true of green vegetables, berries, apples, peaches, grapes, pears and like fruits, eggs and poultry.

Green or "string" beans, corn, peas, tomatoes, berries and beets may be "**canned**" for winter use by simple **sterilization.** Such food after being prepared, as for immediate use, are packed in tin or glass jars which are then filled with water to which one teaspoonful of common salt is added to each quart, and the cans or jars are then set in a suitable flat bottomed boiler on thin slats (to prevent their breakage) and the boiler filled with water until it rises almost to the top of the jars. The boiler is placed over a fire and the water within is **boiled** for varying periods of time, depending upon the kind of food being thus sterilized. Tomatoes require only twenty minutes while corn requires from three to four hours.

If glass jars are used, the tops and rubbers should be kept in the boiling water while the food is cooking and immediately after the jars are removed from the boiler, the tops should be tightly fitted on the jars. This insures thorough sterilization or the killing of all germs of fermentation.

"**Preserving**" is commonly done to "keep" peaches, pears, grapes, berries and like fruits. Usually a pound of sugar is added for each pound of fruit to be preserved and it is boiled for a time sufficient to make of the juice a rather thick syrup. No water is added as the cooking ex-

tracts enough from the fruit to make the syrup. Such foods do not easily "spoil."

Eggs may be stored for winter use by immersing them in a solution of "water glass," which can be obtained from drug stores, with instructions for its use. It is harmless and fresh eggs stored in the later summer months may be kept perfectly for use during the winter months when eggs usually cost a great deal more money.

Refrigeration has changed the market price of eggs, fruits, potatoes, meats, poultry, cheese and many other food products, and it saves from useless waste great quantities of foods every year.

Such foods are preserved for later use by placing them in rooms artificially cooled by **refrigeration.** Nearly all ice plants in good-sized towns and cities have special rooms where, for a reasonable charge, food stuffs may be stored for later use.

Large packing houses keep a large supply of meats, poultry, cheese and like products for many months. Fresh meats and similar foods are shipped by cars and steamers which are so constructed that a low temperature is maintained to prevent the growth of the germs of fermentation or **putrefaction.**

Pickling is another method of keeping meats and certain vegetables like cucumbers, cabbage and corn. Common salt is usually used for this purpose. Corn may be preserved for winter use by cutting it off the cob and packing it in an earthen jar. A layer of corn two inches deep is placed in a jar, this is covered with salt, another layer of corn and salt until the jar is filled. A clean plate is placed upon the mixture inside the jar and a weight used to keep all the corn under the brine which forms. A cloth is placed over the jar, which is kept in a cool place until ready for use.

A quantity of corn for a meal is removed, rinsed in cold water and cooked as if it were fresh from the cob, changing the water while cooking until free from salt. Vinegar is often used for keeping cucumbers and beets.

Dehydration is a method used to preserve fruits, beans, corn and other vegetables. "Dried fruit" or vegetables is another name applied to food kept in this way. By exposure to the hot sun for a number of days, or by a slow heat in an oven, the water is evaporated from such foods until there is too little moisture for germs of fermentation to grow. These foods are then kept in a warm, dry place and used as needed.

Dangers of Foods. Many foods when improperly manufactured, handled, kept, stored or sold may become dangerous to health. For this reason, and to protect the purchaser from substitutions and misbranding, the U. S. Government has passed strict laws to prevent fraudulent claims for food products and their adulteration. "Look at the label" is a good rule to follow if you are desirous of securing your money's worth.

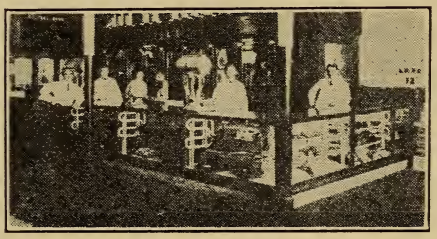


Fig. 35.—A model food market. Observe the dust-proof cases and glass refrigerators for meats.

The food markets should be kept clean, screened, and food for sale should not be exposed to the dust of the street or flies. The clerks should avoid handling food stuffs with unclean hands. Meat markets should be supplied with good refrigerators and they should be kept clean and free from putrefying meat.

Oysters and fish should be kept on ice in dust and fly-proof containers; butter and cheese, in a fly-tight holder, supplied with ice; milk in a tight, well-chilled refrigerator; lettuce, tomatoes, fruits and other foods eaten raw should be well protected from flies and dust and should not be handled with bare hands, because, many times such food thereby becomes infected with germs of typhoid fever or dysentery and is dangerous to health. For this reason, all foods eaten raw including apples, peaches, pears and grapes should be thoroughly washed in clean water before they are eaten.

Summary

Foods, such as certain vegetables, fruits, eggs and meats may be preserved for later use. Many of these foods during some seasons of the year are plentiful and cheap and are wasted, otherwise.

"Canning" of vegetables and fruits may be done by thorough sterilization of the container and contents, by boiling for varying periods of time.

Preserving of fruits is more expensive because much sugar is used, but less food is wasted through "spoiling."

Eggs gathered during the later summer months may be kept for winter use by storing them in a solution of "water-glass."

Meats, fruits and vegetables may be kept fresh for a long time by refrigeration. Pickling and dehydration are employed to preserve certain fruits and vegetables.

Foods may be dangerous to health if they are improperly manufactured, stored, labeled or handled. For this reason, the United States Government and many

states have passed laws to protect people from careless or fraudulent dealers.

Food markets should be kept sanitary and employees should avoid handling many food stuffs with soiled hands. Meat markets should be equipped with clean refrigerators.

Oysters and fish, butter and cheese, lettuce, tomatoes and fruits require careful handling and protection from dust, flies and rodents. Fruits eaten with the peeling on should be thoroughly washed before they are eaten.

Questions

1. What is meant by preservation of foods? Why is it done? Name ten fruits and vegetables that may be "kept."

2. What is canned food? What is necessary to "keep" canned fruit or vegetables from spoiling? Why? What is the commonest method of sterilizing foods? If rubbers and tops of glass jars are not thoroughly boiled what may happen? Why?

3. What is the ordinary method of "preserving" fruits? What is the advantage and disadvantage of keeping fruits by this method? How may eggs be kept fresh for winter use?

4. What is meant by "refrigeration" as applied to foods? Name six foods that may be kept for long periods by this means. How can fresh fruits such as strawberries be shipped long distances without "souring?" Why is this true?

5. What is putrefaction of foods?

6. Name three meats and vegetables that may be preserved by "pickling." What is a common chemical used for this purpose?

7. How would you keep fresh corn for use during the winter months? How should it be cooked?

8. What is meant by dehydration? What are "dried apples?" Evaporated peaches, apricots and "raisins?" How may dehydration of fruits and vegetables be done? Why will such foods "mould" or "spoil" if kept in a warm, moist place?

9. How may foods become dangerous? Why does a label on a package of food usually tell the truth?

10. How would you judge a food market to be properly conducted? Why are refrigerators necessary for meat markets? How should fish and oysters be kept or exposed for sale?

11. Name five fruits and vegetables that should be protected from flies, dust and rodents. Why? What is the danger of handling them with soiled hands?

CHAPTER XV

MILK

This food, when pure, is probably the best food in the world. The human body is fed and grown for many months by the use of this food alone. Usually it is cheap enough in the open market to make it one of the most economical foods for use in the home. On the farm and in small towns it is easily procured and constitutes one of the chief articles of diet at a low cost.

Milk improperly procured, handled or sold can easily

Fig. 36.—Showing the reason milk is frequently unclean and dangerous.

become infected with the germs of typhoid fever, dysentery, tuberculosis, scarlet fever, diphtheria and other infectious diseases.

Care of Milk. On the farm and wherever cows are kept for supplying milk, a few simple rules should be followed to insure a clean supply of milk for the table. The cows should be kept in a clean barn and away from the mire and filth found in the barn-yards of many careless people. She should have clean bedding and her skin and hair

kept free from filth. Her udder and teats should be thoroughly washed and dried before each milking. The hands of the milker should be thoroughly clean. The bucket should be cleaned, "scalded," and sunned between milkings. It should have only a small opening at the top to protect it from the entrance of dirt and flies or covered with a thoroughly clean, fresh cloth at each milking.

The milk should be at once strained and placed in clean containers and set in an ice box or cool place.

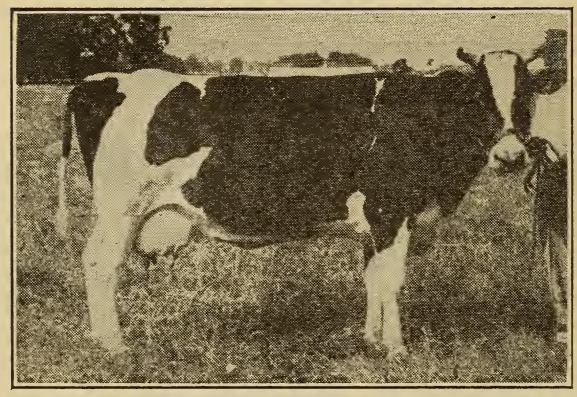


Fig. 37.—A thorough-bred mlik cow, clean and tuberculin-tested.

In a dairy these rules of cleanliness should be followed in procuring the milk and it then should be placed at once in sterilized bottles and upon ice. The milk wagon should have provision made in hot weather for carrying milk packed in ice, and its sale from the street by pouring from an open container should be prohibited.

Cows should be given the "tuberculin test" to determine whether they are infected with tuberculosis and if so found, their milk should not be used or sold and should be killed for meat only when the health officer has passed upon its fitness for food.

Dairymen should be required to obtain from health authorities a "permit" to operate a dairy, which pro-

tects the conscientious dealer from competition with unscrupulous ones, and if the necessary regulations of the health board are not complied with, they should be fined and their license revoked.

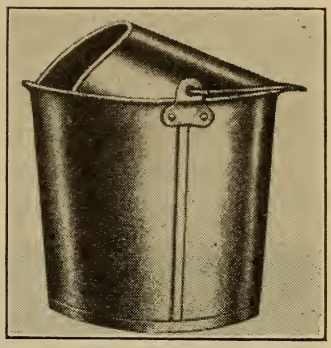


Fig. 38.—A milk pail that excludes much dirt while milking.

"**Market Milk**" is a term used to apply to the mixed milk of a dairy herd; it is usually cheaper in price than "certified milk" which is produced under conditions approaching the ideal and is fairly free from bacteria and contamination. Certified milk when it is on the market should always be bought, even at a higher price, for the feeding of babies and young children.

Skimmed Milk is milk from which the cream has been removed by "skimming" after standing or by the use of a cream "separator" which operates quickly by centrifugal force. It contains all the value of whole milk except the fat (cream).

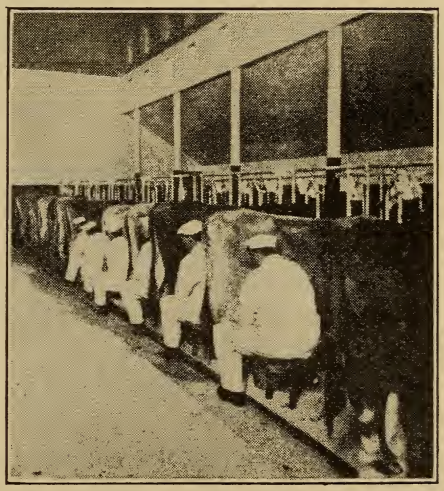


Fig. 39.—A model milking stable for furnishing clean milk.

Butter is a by-product of milk made by "churning"

the cream of milk which has "soured" or undergone fermentation.

Cottage Cheese is the "curd" of milk which has "clabbered" or undergone a form of fermentation.

Buttermilk is a fermented milk remaining after the butter has been removed from it.

Fig. 40.—This cow looks like a good one. The germs of tuberculosis were found in her milk and she was killed.

Cheeses are of many kinds, depending for their appearance and flavor upon the process of manufacture and the curing of the curd obtained from the milk of the cow, sheep, goat or mare.

"Watered milk" is a term applied to milk which has been adulterated with water by dishonest dealers who charge the same price for it as should be charged for a standard or market milk.

Summary

Milk is an economical food and easily procured. Under certain conditions, it can become a very dangerous food, for in it the germs of typhoid fever, dysentery and tuberculosis can easily grow.

Cows should be kept clean by having fresh bedding every day, and their hair freed from filth. The cow-shed and surroundings should be kept clean. Milking should be done in a manner to prevent dirt, flies and

impurities from getting into the milk. The containers must be thoroughly washed and sunned or sterilized. The milk should be at once strained and cooled and if it is sold on the market, bottled.

Dairy cows should be tested for tuberculosis, and if infected, their milk must not be used for food or their meat should not be eaten, unless approved by the health officer.

Dairies should not be permitted to operate unless a permit is secured from health officials, and if unclean milk is furnished, the license should be revoked or the owner of the dairy punished by law.

Market milk is a term applied to milk which is usually sold from dairy wagons.

Butter and cheese are by-products of milk which have undergone certain kinds of fermentation. When the cream is removed from fresh milk, skimmed milk remains. Buttermilk is the sour milk remaining after butter has been removed from it by churning.

Questions

1. Why is pure milk a good food? What fact proves it contains all the classes of food needed to sustain life and build new cells?

2. How can milk become dangerous? Name four disease germs which grow easily in milk?

3. Tell how pure milk may be placed upon the table ready for drinking, giving eight important steps in the production of such milk? Why is each step necessary to insure pure milk?

4. What is the purpose of the tuberculin test? If a cow is so infected, what must be done with such a cow? Why?

5. What is a dairy? Why should a permit from a health officer be secured to operate a dairy? Name five bad conditions found at a dairy which would be sufficient cause for a permit to be revoked by health authorities?

6. What is market milk? "Certified milk?"

7. Why should "certified milk" be procured, when possible, for young children?

8. What is "skimmed milk?" What is its food value as compared to whole milk?

9. How is butter made? What is responsible for the "souring" of milk? What is buttermilk?

10. What is cottage cheese? Upon what does the flavor and appearance of cheese depend?

CHAPTER XVI

WATER

Water for drinking purposes is obtained from wells, cisterns, springs, lakes, artificial reservoirs and running streams.

Wells are shallow or deep, depending upon the depth it is necessary to dig or drill them to reach the underground streams which supply them.

Artesian wells are drilled to the depth of several hundred feet, usually, and furnish a large supply of water which is forced by pressure out of the well at the surface of the ground. Such water is nearly always pure. Potable water, or water for drinking purposes, implies that it shall be free from disagreeable odors, clear in color, free from sediment, and contain no bacteria, showing pollution by surface drainage.

Shallow wells either "dug" or drilled may furnish a supply of clear water in an isolated place far enough removed from alleys, stables, surface closets and other sources of pollution. Well water, spring water or cistern water, which becomes muddy after a rain, should be under suspicion as dangerous, for it is evident that surface water, which may be filled with filth and disease-producing germs, has found its way either through the top, along the walls or into a stream which is a source of supply. In certain limestone districts, such polluted water from the surface, following a rain, may be carried long distances through fissures or cracks in the stone. Shallow wells and springs should never be used as sources for drinking water in densely populated districts.

A properly constructed cistern probably furnishes the

safest supply of water in such districts where it is not supplied by a system of pipes from a reservoir, deep wells, lake or river, under such regulations as are necessary to insure its purity. A cistern should be large enough to furnish plenty of water through the summer months without having to use the summer rains. Its bottom and walls should be lined with brick and coated over with cement so that it is water-tight. A **filter** is an appliance to remove, mechanically, certain foreign substances from water. A simple one for use, holding about two barrels, in connection with a cistern, may be constructed of brick, lined inside with cement and connected at its bottom to the "feed pipe" leading to the cistern. In it are placed layers of charcoal, sand and coarser gravel. It is provided with a tightly fitting top, through which the pipe runs from the roof or other surface where "rain water" is collected by the use of gutters and conducted through the filter into the cistern. The contents of such a filter should be changed at least twice during the time water is being collected through the winter months. Be-

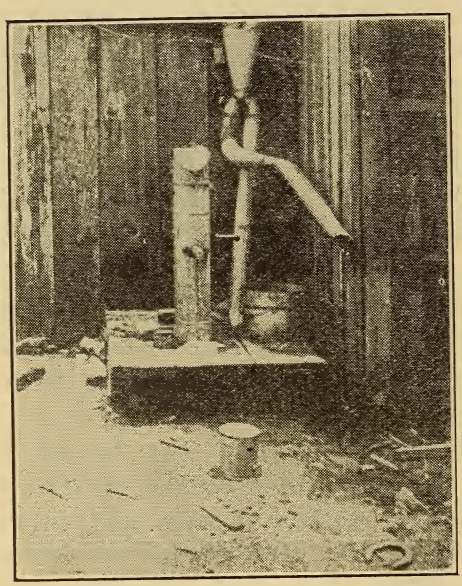


Fig. 41.—A dangerous cistern. There is no filter. It has a leaky top and the surroundings look bad.

fore filling it, the cistern, the filter and gutter should be thoroughly cleaned and a number of hard rains allowed to fall so that the roof may be thoroughly washed free from dust and other impurities carried by rodents, birds or the wind. The tops of wells and cisterns should be water-tight and so constructed that surface water or spilled water cannot drip or filter through into the water supply. The open-top well or cistern is dangerous and water should not be drawn with a bucket and rope which often is permitted to become fouled on the platform where

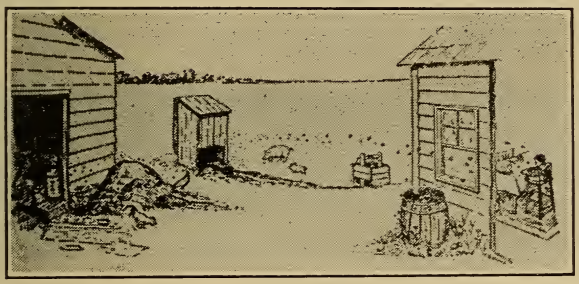


Fig. 42.—Showing why shallow well water is often polluted.

children, chickens, dogs or other animals may carry pollution on their feet. It is best to have a concrete top which extends down the walls of the well or cistern for three or four feet and far enough from its top and around it to provide for drainage of rain-water and that spilled or wasted at the pump.

Polluted Water. Water is polluted when it receives surface drainage. It is customary to think of spring water or well water as being pure because it may be clear and cold. It is only necessary to remember that wells and springs are simply streams of water resulting from the

rains, that have found their way from the surface of the ground. If the surface from which such water comes is a foul alley, stable yard or surface closet, the water is polluted and unfit for drinking purposes. Such water may not contain, at all times, the germs of typhoid fever or dysentery, but if some one is ill nearby and proper methods for killing the disease seed which come from such a person are not used, such water from that neighborhood may contain germs of these diseases and upon being drunk by healthy people, may cause them to have like diseases.

Examination of Water. If drinking water becomes muddy after rains or has a disagreeable odor, or contains

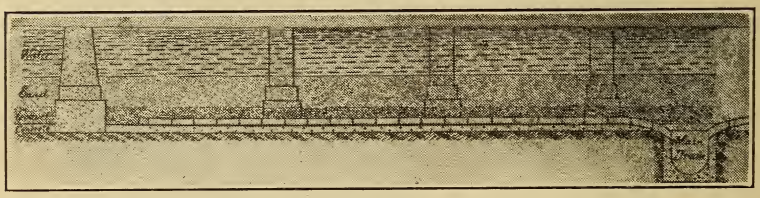


Fig. 43.—A large sand and gravel filter for a city's water supply.

tiny living animals or is being obtained from a well, spring or cistern, near a case of illness from typhoid fever or dysentery, it should be examined to determine its fitness for drinking purposes. In any event, it can be made safe for use by **boiling** for ten minutes. A **chemical examination** of water may reveal the presence of organic matter, either in its pure state or in its process of reduction into inorganic salts. Such an examination may be furnished, free of cost, by the state health authorities to any citizen of the state. A **bacteriological** examination is made to show the presence or absence of any living germs in water. The **colon bacillus,** or the germ that is found in the intestines or bowels of all

animals, is the index for determining the safety of drinking waters. If this germ is found in fairly large numbers, the water is condemned for drinking purposes, for it shows that such water is receiving drainage from stables or like foul places and may, if typhoid fever or dysentery appears in the neighborhood, transmit these diseases to users of the water. Such an examination is usually made, free of cost, to any teacher, householder or citizen of the state, upon request to the state health authorities.

Purification of Water. Water found in rivers and small streams is usually polluted by drainage from the more or less populated country forming their watersheds. The Ohio river, for example, is but a vast sewer, which constantly receives all the wastes from hundreds of cities and towns. Its water for drinking purposes is made dangerous for this reason unless it is properly purified. It is not practical to boil all the water needed by a large city or town. It is, therefore, purified by **sedimentation filteration** and treatment with certain chemicals, as **chlorine.** By sedimentation is meant the process of separating the suspended, solid matter in water from it, thus restoring its clarity. A chemical, usually alum, is added in solution to the water to be treated, and in a

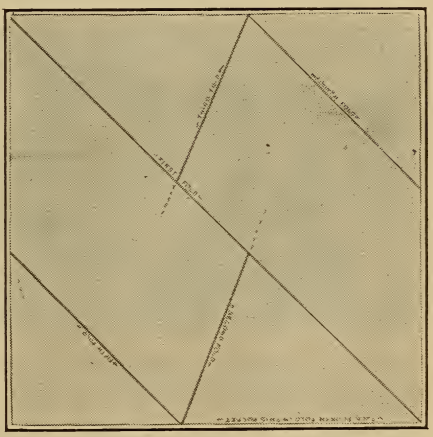


Fig. 44.—Showing the way to make a drinking cup by folding a clean sheet of paper.

specially constructed tank or reservoir, of sufficient size to supply a community with enough water, the water is made to pass slowly through the tank by means of incomplete partitions (baffle walls) and when it reaches the outlet pipe at the upper and most distant end, the solid matter causing its **turbidity** has settled to the bottom and only clear water it withdrawn. It is sometimes necessary to supplement this action on water by filteration. **Filteration** is a plan of treating water through filter beds of sand, coke, gravel or some similar substance to remove foreign matter, including bacteria.

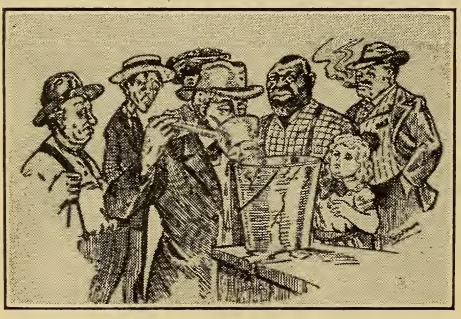


Fig. 45.—A common drinking cup is too "common" to use.

Chemical treatment of water is often necessary to purify it for cities, towns or homes. In large plants **liquid chlorine** is added to water in the proportion of about three parts to the million of water, which kills the ordinary germs in water liable to produce disease. A like amount of fresh **chloride of lime** or "bleaching powder," added to water, is a method of purifying it in schools, homes or small towns. One grain of potent chloride of lime thoroughly mixed with five gallons of water is sufficient to purify it within twenty-four hours. Chloride of lime, exposed to air, soon loses its chlorine and is of no more value than chalk for this purpose.

The Common Drinking Cup is a dangerous weapon. Its use should be prohibited in schools, hotels, public offices and all public places. It may easily carry infections

of tuberculosis, diphtheria, influenza, scarlet fever or one of the vile social diseases, from a person so infected, to a healthy person. Every person should carry a cup when traveling or at school and forbid its use by others. Individual drinking cups may be cheaply made of waxed paper by folding it successively.

Drinking Fountains should be installed in schools, depots and other public places where a number of people must quench their thirst. They are so arranged that a stream of water is made to bubble up from a spout over which, but not touching it, the mouth is held and by slight suction the thirst may be satisfied. There are a number of these on the market but one may be easily constructed, care being used to insure a clean and fresh supply of pure water at all times.

Summary

Water for domestic use is obtained from wells, cisterns, springs, lakes, rivers and artificial reservoirs. Artesian wells usually supply a potable water.

Shallow wells and springs in thickly settled communities are liable to furnish an unsafe water for drinking purposes.

Cisterns, when built right and carefully managed, are safest to use for storing water, when this is necessary.

A cistern should always be provided with a good filter, and it should be cleaned at least twice a year. Care must be used in collecting winter rains for a supply of water for cisterns. An open-top well or cistern is unsafe, and each should be provided with a well-fitted pump and concrete top and sides so that surface or spilled water is not permitted to enter. Surface water from foul places is danger-

ous to drink and may contain germs of typhoid fever or like diseases, if any one having such illness lives near such a supply of water. Well water, or water from springs, or badly built cisterns, which becomes muddy after rains, may be unsafe to drink and it should be boiled before using it for drinking purposes. It then should be examined, chemically and microscopically, in a laboratory where organic matter or bacteria may be found present or absent. When colon bacilli are found in drinking waters, it proves that the water from a foul surface is reaching the supply and such water is dangerous to drink.

Water from rivers and small streams, in populated districts, is usually polluted. When great quantities of water are to be supplied, as in cities, water from rivers is usually used. It is first purified by chemical and mechanical means. Sedimentation and filteration are the methods usually employed. Three parts of chlorine to a million parts of water are enough to kill typhoid germs in drinking water within twenty-four hours.

Fresh chloride of lime contains chlorine and may be used to sterilize drinking water for schools, homes and small water plants. The use of a common drinking cup is prohibited by law in many states.

A drinking fountain should be used in public places, so that a fresh supply of pure water may be supplied to each person without danger of becoming infected with tuberculosis, diphtheria and similar diseases.

Questions

1. Name six sources of drinking water.
2. What supplies wells and springs with water? What are artesian wells?

3. What is a potable water? Under what circumstances may wells or spring water be potable? How may water in wells or springs become infected in limestone countries?

4. When should cisterns be constructed? Tell how a cistern should be built? What is a filter? How is it used? Is it necessary to change the contents of a filter? Why? Why should the roof of a building, from which water for the cistern is collected, be washed? How is it washed?

5. How would you keep surface or spilled water from finding its way into a well or cistern? Was the "Old Oaken Bucket" a safe way to supply water? Why?

6. How is water often polluted? What is polluted water? Why is such water dangerous to drink?

7. What diseases may be spread by the use of polluted water? Why are such disease seed sometimes found in water?

8. Give four reasons why drinking water should be examined. What is the quickest and easiest way to make a dangerous water safe to use?

9. How is organic matter found in water? What is a bacteriological examination of water? What does it mean if the laboratory report shows the presence of colon bacilli in water?

10. Why is river water usually polluted? How is it purified for use in cities?

11. What is sedimentation of water? How is it done?

12. What is meant by filteration of water? How is it usually done?

13. What chemical is used by cities to kill bacteria in water? What strength solution is used?

14. What is bleaching powder? How would you use

it to purify water for use in schools? How would you keep it potent?

15. Why is the common drinking cup dangerous? What diseases may be spread by its use? Make a drinking cup by folding a piece of clean paper.

16. What is a drinking fountain? Where should one be used? How is it arranged? How is it used?

17. If a drinking fountain is provided and its source of supply is a tank or barrel, which is left open or is not cleaned or filled with pure water, of what value is it? Why?

CHAPTER XVII

THE TEETH

Food before it can be absorbed and assimilated in the body cells must be reduced to a liquid. Solid foods, as meats and vegetables, must be reduced or ground to small pieces by chewing. The process of mastication, insalivation, already described, reduces the food to a "pulp," or half-liquid mass.

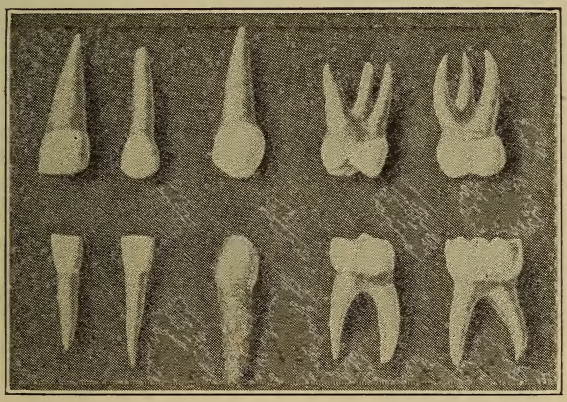


Fig. 46.—The temporary or "milk teeth."

The teeth, therefore, are one of the most important aids to perfect digestion.

Why do not young babies have teeth?

During a lifetime nature supplies the body with two sets of teeth. The first set of teeth is called temporary teeth and are twenty in number, ten in each jaw. They become loose and yield their places, beginning at about the age of six years, to the permanent teeth, thirty-two in number, sixteen in each jaw. The permanent teeth at

the age of twelve years have usually appeared, with the exception of four back teeth, which are called "wisdom" teeth, and these appear near the age of twenty-one. The first molars of the permanent set appear near the age of six years.

Structure of Teeth. Teeth are bone-like in their structure. A tooth is made up of a **crown,** the **neck** and the **root.**

The crown is the part showing above a healthy **gum,** and is covered with **enamel,** a glistening, hard material

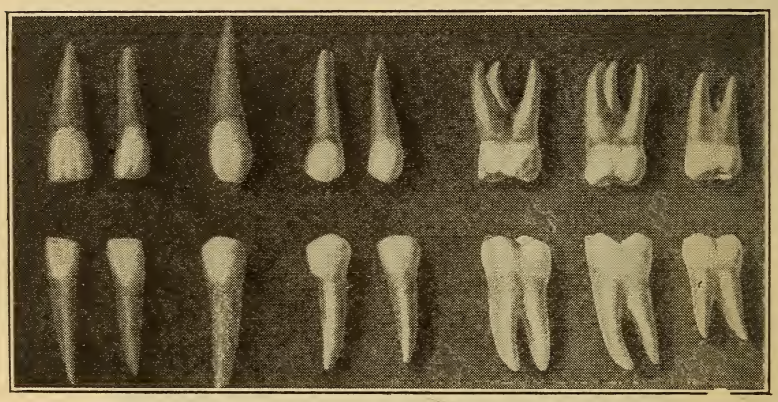


Fig. 47.—The permanent teeth.

which is made to stand a great deal of grinding, without wearing away. The neck of the tooth is the part covered by the **gums** and often shows, when a disease (Riggs' or Pyorrhea) has caused the teeth to become loosened. The root may be a single one, as in the front teeth, or double, as in the lower "jaw" teeth, or three-pronged as in the upper jaw teeth.

If a tooth is sawed across, three parts are seen. In the center is a soft mass which contains nerves and blood vessels. Surrounding this **pulp,** is a hard, bony mass, in

which are blood vessels and nerves for supplying the tooth with nourishment. The outside layer is the enamel, which is the hardest substance in the body, and receives no blood supply. For this reason, if it becomes broken off or is permitted to decay, it is not rebuilt and the tooth is in danger of being destroyed. The root of a tooth is planted firmly in the jaw bone and surrounded by a supporting, bony structure called **cement.** It is through the root that the nerves and blood vessels reach the pulp chamber.

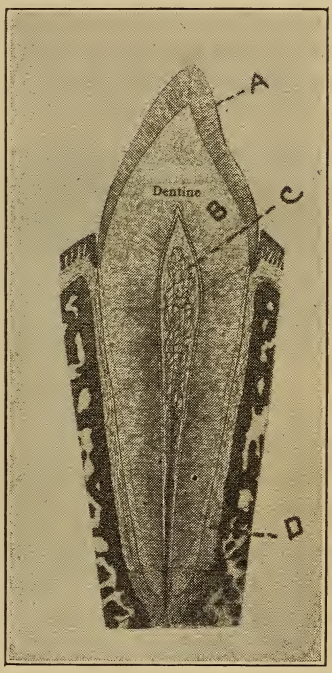


Fig. 48.—Showing the structure of a tooth. A. Enamel B. Dentine. C. Pulp chamber with nerves and blood vessels. D. Cement.

The Shape of Teeth. It will be seen that the four front teeth (the incisors) are broad and sharp like a chisel. These are used for cutting food into smaller pieces; back of these are teeth pointed like a pencil (the canines) and back of these are teeth with broader, flater, grinding surfaces (the bicuspids and molars.)

Decay and Injury of Teeth. Teeth may be injured by falls, blows and muscular efforts in biting upon some hard substance as nuts or metal. Teeth loosened by a fall or blow may become firmly fixed again, if a competent den-

tist is consulted, who can anchor them tightly until nature repairs the cement about their roots. If the enamel is cracked, it should at once be repaired by a dentist, who will enlarge the opening, destroy the infection and fill it with a metal like **gold** or an **alloy** of metal, or cement. This prevents decay.

By decay of teeth is meant a destructive action upon the enamel and body of a tooth by certain bacteria, which are always found in the mouth. These bacteria find in

Fig. 49.—Teeth lost from neglect. The only remedy is a "bridge" or "plate."

the dark, warm, moist mouth, when food is not washed after each meal from the teeth, an ideal place for growth. Their growth produces an acid about the teeth which chemically destroys the lime salts in the enamel and body of the teeth. When once a hole is made in the enamel, destruction of the softer body of the tooth is rapid. The nerves are then exposed and "toothache" results. This pain is nature's kindly warning that a tooth is being destroyed, and should be regarded as her appeal for its repair.

Care of the Teeth. No one would think of preparing food with a meat grinder, if it were not thoroughly washed each time after being used. It would become foul and have a disagreeable odor and the germs of putrefaction, when eaten with food prepared with an unclean grinder,

Repair of Teeth. It is far better to prevent the decay of teeth than to repair them. One should go to a good dentist, at least, twice a year and have the teeth examined and repaired, if needed.

If "tartar" has collected around the gum, it should be removed. In the first appearance of "toothache" the tooth should be repaired or "filled."

Riggs' Disease or Pyorrhea, causes the gums to recede from the teeth and they become loosened. This condition calls for immediate treatment by a dentist until the trouble is relieved.

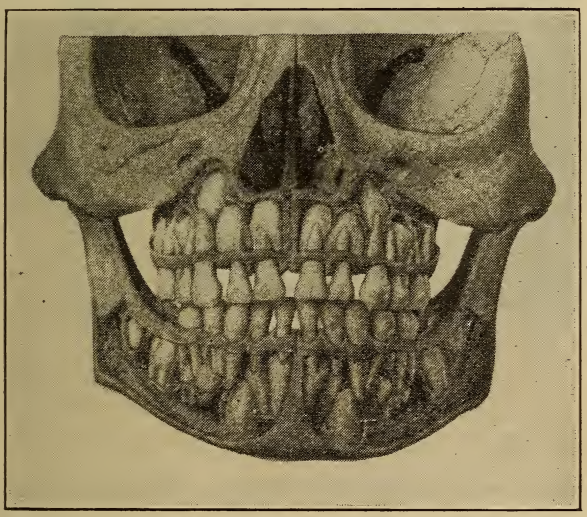


Fig. 52.—Showing how the permanent teeth displace the temporary ones.

When teeth are so badly neglected that some of them have been extracted, or "pulled," a dentist may be able to fill the gap with false teeth by means of a "bridge." This restores the function of the teeth and if the front teeth have been lost so that bridges may not be employed,

a "plate" containing one or several teeth may be made by the dentist. If, for any reason, all of the teeth in the upper or lower jaw, are lost, a set of "false teeth" can be used. False teeth should be secured only as a last resort for they are not sightly, interfere with speech, become foul quickly and require frequent cleansing.

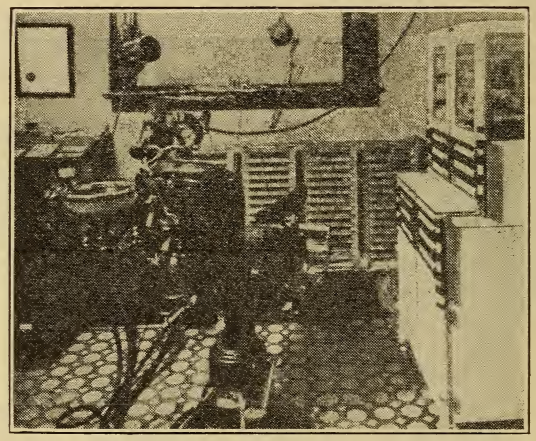


Fig. 53.—A properly equipped dentist's office.

Summary

The teeth are important organs of digestion being used to help reduce coarse foods to a liquid ready for absorption.

The temporary teeth, twenty in number, begin to make their appearance during the first year of life and are usually displaced at the age of twelve by the permanent teeth, thirty-two in number.

The crown, root, and body compose a tooth which is covered on its exposed surface with enamel. The gums cover the body of a tooth and its root is firmly cemented

in the jaw bone. Blood vessels and nerves enter the pulp chamber of a tooth through the root, and are distributed throughout the tooth to supply it with nourishment.

Teeth are shaped for cutting, tearing and grinding food and are named incisors, canines, bicuspids, and molars. They may be injured by mechanical or violent means or may decay by the action of bacteria which produce an acid which dissolves their mineral salts. Unless the teeth are kept clean, decay results and they are finally destroyed, causing much pain and even ill-health.

A competent dentist should be consulted twice a year to inspect the teeth and repair them, if needed. Bridges, plates, and false teeth can be made to do the work of missing teeth.

Many times rheumatism or heart disease follow infections or abscesses at the root of badly decayed teeth.

Questions

1. What is the principal function of the teeth? Why are teeth necessary for digestion of food?

2. What is insalivation? Mastication?

3. What is the best evidence to show that very young babies should not be fed solid foods?

4. What are the temporary teeth? How many? When do they begin first to appear? What take their place? Can you explain why there are twelve more teeth in the last set? What are "wisdom" teeth?

5. When does the first jaw tooth of the permanent teeth appear? Should a decayed jaw tooth of a child of seven years be pulled without consulting a dentist? Why?

6. What is the crown of a tooth? The body? The root? What is enamel? What is meant by the gums?

7. How would you suspect one might have Riggs' Disease? What other name has it?

8. Why do you think the jaw teeth have spreading roots?

9. What is the "pulp" of a tooth? What is its function or use? Does blood circulate through the body of a tooth? Why? Does it flow through the enamel of a tooth? Why?

10. If enamel is cracked or broken, does nature rebuild it? Why?

11. Can you think of any reasons why the shape of the teeth proves that man eats both animals and vegetables for food? Why are dogs', cats', lions', and tigers' teeth of the pointed, sharp kind?

12. How may teeth be injured? If a tooth is loosened by violence, must it be pulled out? Why? What should be done with it?

13. Why do teeth decay? Explain why bacteria cause decay of teeth. What is toothache? Explain why it may be considered a "blessing in disguise."

14. Show why unwashed teeth are filthy? How they may cause ill-health. How can decayed or unclean teeth cause a "bad breath?"

15. How may teeth be cleaned? How often and when should teeth be "brushed?"

16. How would you prevent decay of the teeth? Is it wise to wait for a toothache before consulting a dentist? Why?

17. Can pyorrhea be cured? What would you do if you suspected you had it? How may one suspect that pyorrhea is present?

18. What is a "bridge"? What is its need and purpose? When may a "plate" be used?

19. What is meant by a "set of false teeth"? Give four reasons why they should be secured only as a last resort?

20. Name two diseases sometimes caused by badly decayed and abscessed teeth? Explain how this occurs.

CHAPTER XVIII

THE CIRCULATORY SYSTEM

In the preceding chapters it was shown that the body must have food to furnish it with energy, heat, and to repair its parts. This food must be digested and absorbed into the blood ready for **assimilation.** Not only must the body cells have food but they must be supplied with oxygen from the air. The body must also, rid itself of poisonous wastes and dead cells which result from the expenditure of energy and the production of heat. These operations are carried on through the **circulation** of the **blood** and **lymph.**

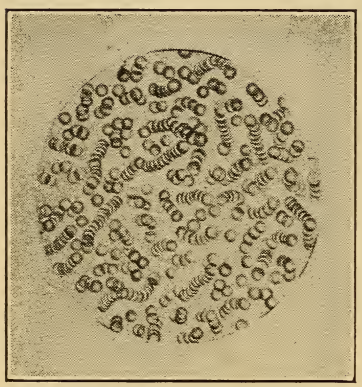


Fig. 54.—Red blood corpuscles. They often are collected in rolls like coins.

If a cut is made through any part of the skin, at once there appears a flow of a red fluid, the blood. It flows through every part of the body except in the hair, nails, enamel of the teeth, and outer layers of the skin.

If any part of the body is deprived of blood for a few hours, it dies.

For hundreds of years it was not known that blood circulates through the body and when Harvey of England in 1628 proclaimed his discovery, he was ridiculed and persecuted before his observations were proved. Now every school child knows something of the circulation of the blood and its functions.

So necessary is it to maintain life, that if the circulation should stop for a few minutes, death of the whole body and its millions of cells would result.

The functions of circulation, then, are to carry oxygen to the body cells; to furnish them with food and water; to carry away wastes, to preserve an even degree of heat in the body, and to aid in the defense of the body against disease.

The Blood. The blood is a red, sticky opaque fluid with a peculiar odor and a salty taste. It is a bit heavier than water. It is neither an acid nor alkali (or salt). It comprises about seven and one-half per cent of the body weight or about six quarts for an average man.

Fig. 55.—The large one, a white corpuscle in about 500 red ones.

If fresh blood is caught in a vessel and allowed to stand, it will be noticed that it becomes thicker, or more **viscous**, and later sets into a firm jelly. If not molested, the mass contracts and a clear straw colored fluid, the **serum**, appears. The more solid mass is a "clot."

The blood is composed of **plasma** and **corpuscles**. The plasma is the fluid part of blood and it may be called the blood minus the corpuscles.

Corpuscles are cells suspended in the plasma of the blood. They are of two kinds, the red and the white. The red are smaller than white corpuscles and outnumber them five hundred to one. The red corpuscles carry oxygen to the tissues and collect carbon dioxide from

them. The white blood cells carry food to the body cells, collect wastes and destroy germs that threaten the life of

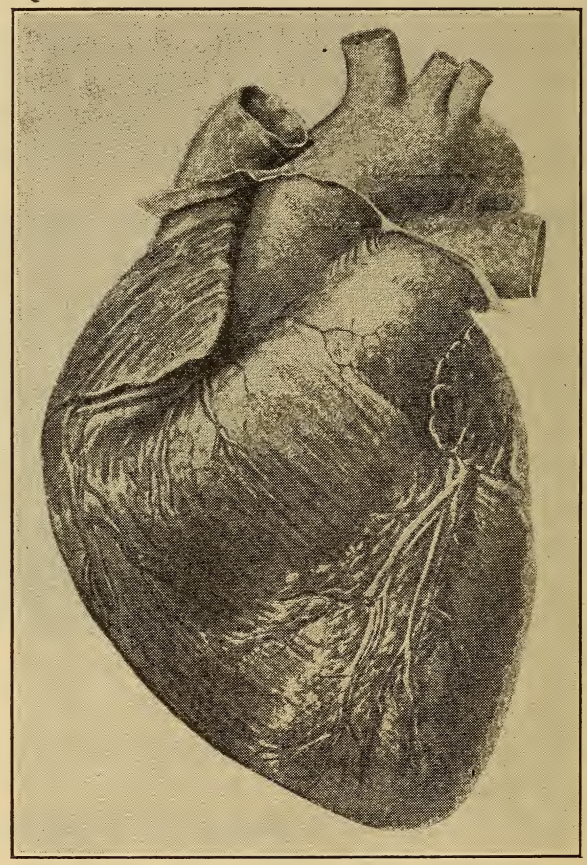


Fig. 56.—The heart, showing large blood vessels, and positions of its right chambers.

cells, and have the power of self-movement. They are sometimes called the "wandering cells."

The blood is carried to every part of the body through the action of the organs of circulation; these

are the **heart, arteries, capillaries** and **veins** and **lymphatics.**

The Heart. The heart is a pear-shaped, hollow, muscular organ about the size of one's fist. It is in the chest a little to the left of the middle of the breast bone (sternum) and its "beat" can be plainly felt in this region. It is enclosed in a sac called the **pericardium.**

The heart is a pump and a wonderful one it is. It has four cavities, two **auricles** and two **ventricles.** All the blood of the body is emptied into the ventricles where it is pumped through every part of the body. The right side of the heart receives the blood as it returns from its trip through the body and pumps it through the lungs where it is purified. The left side of the heart receives the blood from the lungs and pumps it throughout the body. It is evident that the left side of the heart must be the stronger. Why?

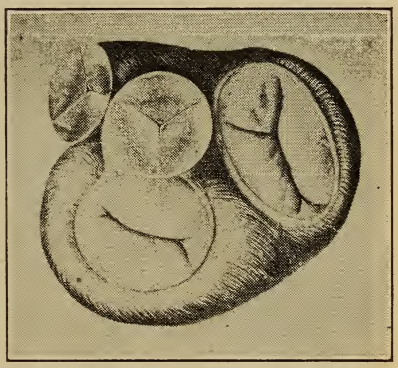


Fig. 57.—Showing the valves of the heart. The folds close tight at the proper time and the blood is forced onward in its course.

The walls of the left ventricles are much thicker than the walls of the right ventricle, and the walls of the auricles are thin for their only work is to force the blood into the ventricles below.

The heart pumps the blood by the contraction of its muscular walls very much like water is forced out of a hollow rubber ball by squeezing it with the hand. If one squeezes a soft rubber pipe filled with water, the water

is forced out of each end. If one end of the tube is plugged, all the water will be forced out of the other end. So it is evident that some arrangement has been made to keep the blood moving onward on its course when the muscles contract. This is done by means of valves placed between the auricles and the ventricles. These valves are thin membranes so arranged that no resistance is made to the flow of blood from the auricles into the ventricles, but when the heart pumps, these valves at once close tight and no blood is permitted to squirt backwards. Some diseases like "rheumatism" often cause these valves to leak and some blood is permitted to escape back into the auricles, and a curious sound is made by the blood passing between them. This is called a "leaky heart."

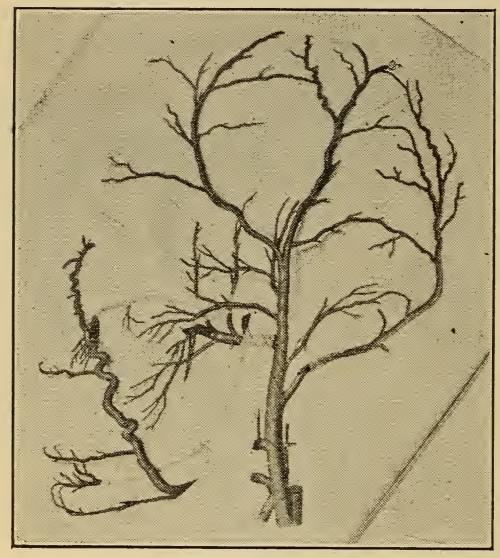


Fig. 58.—Arteries of side of the face and head, showing how arteries divide into smaller branches.

The Work of the Heart. The heart beats in an adult about seventy-two times every minute. In health its work is regular and time is given between each beat for the heart to rest. It is the hardest-worked organ in the body and its work every day is as much as would be

done, if a man carried two hundred pounds to the top of a mountain two thousand feet high. When the muscles of the body are active, as in exercise, the heart's action is more rapid and greater effort is made each beat to

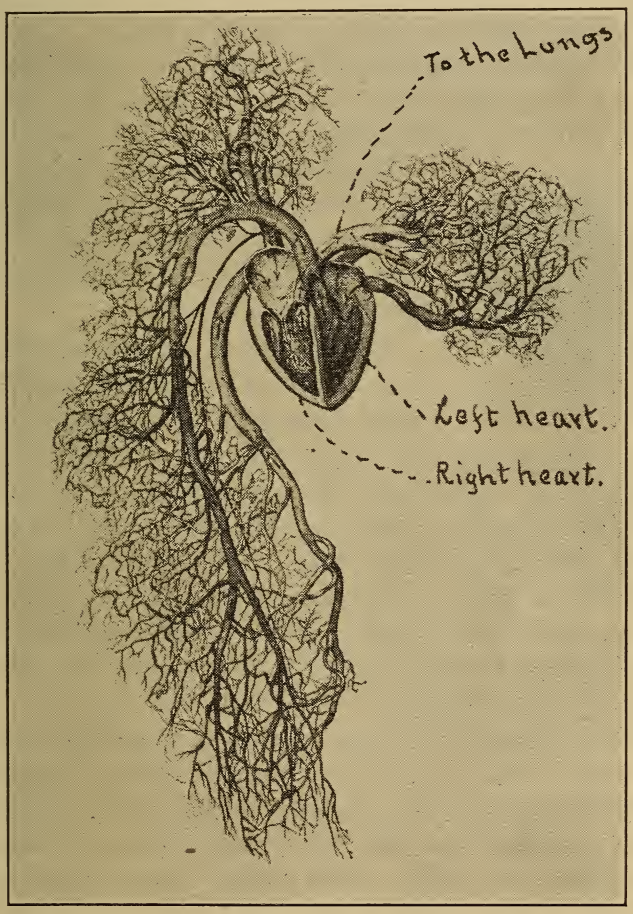


Fig. 59.—Showing the general plan of circulation from the left heart through the arteries, capillaries and veins of the body, returning to the right heart, thence through the arteries and capillaries of the lungs and returning to the left heart.

keep up the circulation of the blood. Athletes soon develop a strong heart muscle and if training is abruptly stopped, the heart may be impaired. For this reason one accustomed to much physical exercise should grow gradually accustomed to a sedentary life, if it becomes necessary, and regular exercise practiced daily.

The heart is nourished by its arteries, veins and capillaries. The heart arteries have their origin from the large single artery (aorta) which leaves the left ventricle.

Fig. 60.—A capillary cut across, showing blood cells in the tiny tube (greatly magnified). Note the white blood cells escaping through the wall.

The Arteries. Imagine what a complex framework of pipes there would be in a city water-works if all of the pipes could be freed from the structures which conceal them.

There would be a main pipe line running from the reservoir to supply each house in the city. There would be large and small pipes branching from the main one, and still smaller ones which would supply each house; from the pipes leading to each house, there would be smaller ones to supply each room, until finally there would be seen a great network of pipes, large and small, through which water for the city could be supplied to every part of it.

The arteries of the body operate very much in this way. From the heart, which may be called the "reservoir," there are two large arteries (or pipes) one (the pulmonary) leading from the right ventricle to the lungs, and the other (the aorta) which is very much larger, leading to every organ, muscle, bone, and structure in the body.

As the arteries pursue their way through the body, they give off branches, here and there, which become smaller

and smaller as the distant parts are reached until, finally, they are so small that, with the naked eye, it cannot be seen they are "pipes" or tubes at all. These tiniest of arteries are called **arterioles.**

Structure of Arteries. The arteries are so constructed that they expand and contract as each new volume of blood is pumped into them. This is done for two reasons; to relieve the work of the heart and to make an even, continuous flow through the **capillaries.** At the exit of the heart, both the aorta and pulmonary arteries have valves arranged so that when the arteries recoil after being stretched by the heart beat, no blood can be forced back into the heart. By this arrangement the blood is forced on its way to all parts of the body. When an artery is cut, the blood, bright red, escapes in a "spurt" at each beat of the heart.

The Capillaries. When an artery has been divided and subdivided until its smallest branches (the arterioles) are reached, the blood enters the **capillaries.** The opening through them is often so small that tiny blood cells must make their way, one by one. If the tail of a living tadpole is spread upon a tiny glass and placed under a microscope, the blood cells may be seen winding their way through the capillaries. Their walls are very thin, having only a single layer of cells, held together by a bit of connective tissue. It is in the capillaries that body cells receive their food and give up their wastes.

Veins. As the capillaries begin to unite themselves into larger tubes, **veins** are formed. These tiny veins connect with one another, making larger veins until finally they all merge into two large veins, which **return** the blood into the right auricle of the heart. In the veins are placed at intervals of one to several inches, folds of membrane,

so arranged that blood cannot flow backwards, but with the force of the heart, pushing the blood along, and by

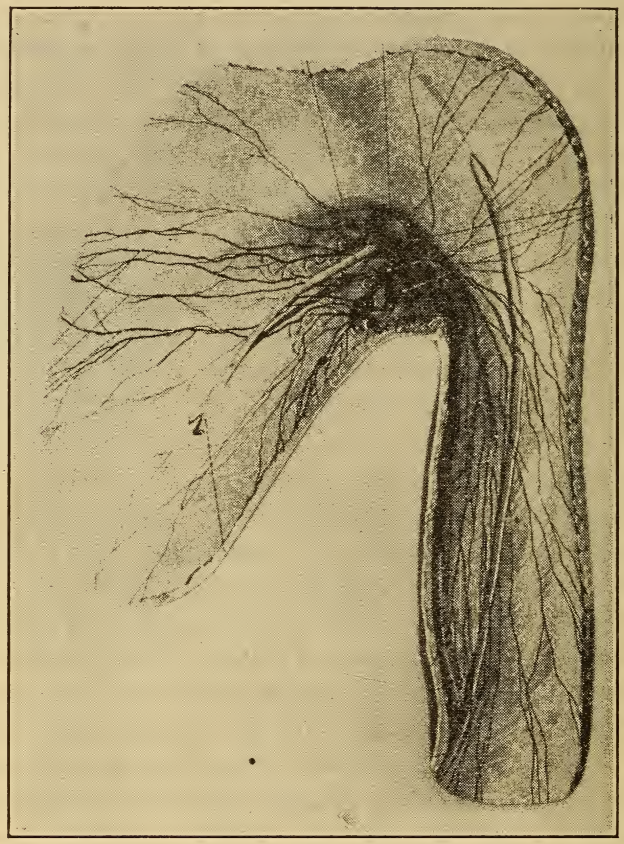


Fig. 61.—Showing lymphatic glands under the arm and the lymphatic vessels which carry lymph through them.

the contraction of the body muscles, the blood is made to return to the heart. When a vein is cut the blood (dark red) flows in an even stream.

The blood cells have now given up some of their food to the body cells and have collected waste materials from them, and it must now be pumped through the lungs to be purified in their capillaries and brought back through the veins to the left heart to be again pumped on its life-saving journey through the body.

The Lymphatics. One wonders where body cells get their nourishment, and when the change of food into flesh is made. If the blood circulate continuously, does it stop long enough to give up its food, or does it do it "on the run?" This process is carried on in the lymphatic vessels.

Blood plasma, the liquid part of the blood which contains the white blood cells, does not always accompany the red blood cells.

As the blood goes through the capillaries, the blood plasma, carrying its white cells with nourishment, **escapes** through the walls of

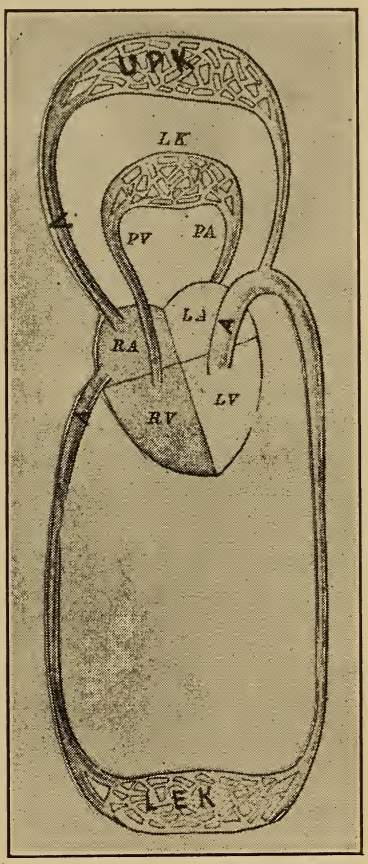


Fig. 62.—Outline of the circulation of the blood. L. A. Left auricle. L. V. Left ventricle. R. A. Right auricle. R. V. Right ventricle. P. A. Pulmonary artery to lungs. P. V. Pulmonary vein from lungs. U. P. K. Capillaries of upper part of body. L. E. K. Capillaries of lower part of the body. A. Aorta. V. Returning veins.

the capillaries into tiny spaces around them. This fluid is now called **lymph,** which is another name for blood plasma. These spaces are the **peri vascular spaces,** or the beginning of the lymphatics. It is here that the body cells are bathed in blood plasma and each cell may take what food it needs from the white cells and they, in turn, pick up its waste matter.

From these very small lymphatics, the blood plasma flows through connecting channels, very much like the blood is collected into the veins from the capillaries, and finally empties into two large tubes. These tubes enter directly into the deep veins in the right and left shoulder and their lymph is returned with the blood to the right heart. **Lacteals** are lymphatic vessels which take up fatty portions of the digested food from the small intestines and carry it, with the lymph, to the circulation through the large lymphatic vessels in the neck. Lymphatic vessels have valves similar to those found in the veins so that the flow of lymph is maintained in only one direction towards the large veins in the region of the shoulder.

Lymph Glands. As the lymphatics pursue their way through the body they pass through many whitish bodies of varying sizes, the largest being about the size of a grape. Here the lymph is filtered or "strained" and bacteria that have found their way into the blood are made prisoners, as it were, and destroyed by the white blood cells. A "kernel" under the arm, or in the thigh is an enlarged lymphatic gland or **node,** which has "taken prisoners" some germs from some "sore" or infected place lower down the arm, body or leg.

Summary

The circulation of blood and lymph is necessary for the assimilation of food, the production of heat and energy and for the defense of the body against disease.

The blood is composed of plasma and red and white corpuscles, and it is carried to every part of the body by the heart, arteries, veins, capillaries and the lymphatics.

The heart is enclosed in the pericardium and is divided into two auricles and two ventricles.

The blood flows through the left auricle into the left ventricle into the aorta and through branching arteries. It enters the capillaries and is collected by connecting veins and returned to the right auricle; from there, it flows into the right ventricle, into the pulmonary artery and through the capillaries of the lungs where it is returned, purified, through the veins, into the left auricle. The same beat of the heart performs at one time the work of both sides of the heart.

Lymphatics collect blood plasma from the spaces around the capillaries into larger lymphatic vessels and empty the lymph into large veins near the neck.

Questions

1. Name five functions of the circulation. What two fluids make up the circulation?
2. When and by whom was the circulation of the blood discovered?
3. How do you know that circulation is necessary to maintain life?
4. What is blood? How much blood in an average man?

5. What is a "blood clot?" Blood serum?

6. Of what is blood composed? What is the function of red blood corpuscles? Of the white corpuscles? What is plasma?

7. Describe the heart. Where is its location in the body?

8. What are the auricles? The ventricles?

9. Is there any flow of blood between the auricles? Is there any flow of blood from the left ventricle to the right ventricle?

10. What is meant by "right heart?" The "left heart?"

11. How does the heart compel the blood to circulate? Illustrate its action.

12. What arrangement is made in the heart to keep the blood flowing onward through the blood vessels? What is a "leaky heart?" How may it be produced?

13. What is the rate per minute of the heart beat? At the same rate, how many times will the heart beat in an hour? A week? A month? A year?

14. What effect does muscular exercise have on the action of the heart? What is the danger following a period of training in athletics? How can this danger be avoided?

15. How is the heart itself nourished?

16. How do arteries distribute blood to all parts of the body? Compare their distribution to a system for supplying a city with water.

17. What are arterioles? How small are they?

18. If an artery is cut, how would you know it?

19. What is the difference in size between the smallest arterioles and capillaries into which they pour their blood?

20. What are capillaries? What is their function? How small are they? With what are capillaries connected at each of their ends?

21. What are veins? How large are they at their smallest beginnings?

22. What is the function of the veins? What arrangement is made to keep the blood moving steadily toward the heart? What force keeps the blood flowing through the veins?

23. If a vein is cut, how would you know it?

24. Into what opening does the blood from all the veins empty? Why is the blood pumped to the lungs? Where does the blood go after it leaves the lungs and is returned to the left heart?

25. What are the lymphatic vessels? What is their function?

26. What is lymph? What cells are always found in it? Why?

27. What are the smallest of the lymphatic vessels called? How is lymph collected? Into what do they empty. Where?

28. What are lacteals? What is their function?

29. What are lymph glands? What is their chief function? What is a "kernel?" What causes it?

CHAPTER XIX

BLOOD CELLS

The Red Blood Cells are round in shape like a nickel but each side is hollowed out or concave, and are so small that about thirty-two hundred of them, placed side by side, would only measure one inch. They are about one-fourth as thick as their diameter. There are about five million of them in one average "drop" of blood. Millions of them are "worn out" or destroyed every hour and new ones are manufactured to take their place.

When the circulation in the capillaries brings them in close relation with the body cells, red corpuscles give up their oxygen and absorb carbon dioxide from the body cells. This process is spoken of as **oxidation** and the exchange of the two gases (oxygen and carbon dioxide) is carried on by a process of **osmosis.** The red corpuscles in the capillaries of the lungs are separated from the air we breathe only by the thinest layer of cells, and there osmosis again occurs, and the red blood cells exchange their carbon dioxide for the life-giving oxygen.

Oxidation in the tissue cells creates heat and it is this operation together with the exchange of food for cell wastes that keeps the body warm.

The red color of blood is due to the coloring matter in the red blood corpuscles. Sometimes, as after a loss of blood from an injury, or a long period of wasting sickness, as typhoid fever, malaria or tuberculosis, these cells lose their coloring matter, or the blood loses too many of these cells. The body is said to be "pale." The lips, finger nails and eyelids are not so rosy in color. This condi-

tion is known as **anemia,** and rest, good food and the attention of a competent doctor are needed.

White Blood Cells are much larger than red blood cells and have the power of movement like an amoeba. In addition to their chief function of carrying food to the body cells, they are the "policemen" of the body.

If a disease germ finds its way into the tissues, the white blood cell at once stops it, folds itself around it and digests or destroys it. If too many germs get into the tissues, hundreds of white blood cells collect around the invading enemy and seek to destroy them. A "boil" or "pimple" or simple "sore" is the battle ground of a fight between the common "pus" germs and the white blood cells. Such a condition is called an **inflammation.**

Fig. 63.—Showing how white blood cells move about. A. At rest. B. Reaching out in two directions. C. Reaching in one direction.

Fig. 64.—Showing white blood cells digesting disease germs after "swallowing" them.

If the white blood cells should win in their fight with the first attacking germs, there is very little inflammation with its pain, redness, swelling and heat, and the tissues soon become **normal** or well.

If the invading germs are large in numbers and strong in attack, nature sends a large number of white cells as "reserves" to keep the infection out of the blood.

If the germs are the victors, the infection spreads

through the lymphatics, where the lymphatic glands strive to check their advance. If the glands and their white cells win in this new battle area, the "kernels" soon become smaller and disappear; if the germs are again victorious, their poison is poured into the blood stream and one of the many forms of "blood poisoning" may develop.

When the white blood cells are the victors in the conflict with many of the germs which produce disease, the cells are so prepared and trained for fight, that, if such germs enter the body in later months or years, they are destroyed at once. This condition of the body is referred to as **immunity.**

Fig. 65.—Red and five white blood corpuscles in inflammation. Note the relative increase of white cells. The white cells are the "reserves" brought into the fight against attacking germs.

Vaccination against smallpox so trains the white blood cells that for many years afterwards a vaccinated person may live with a person having smallpox and never "take" it.

An unvaccinated person would be almost certain, under the same circumstances, to contract the disease. Smallpox used to be as common as measles is now, and killed and disfigured its hundreds of thousands of victims. Now no one needs have this loathsome disease unless it is preferred to a simple, harmless vaccination.

Not a single case of smallpox occurred in the millions of soldiers of the Allies in the European War, because each of them had been vaccinated against it.

An attack of diphtheria, scarlet fever, typhoid fever, measles, whooping cough, chickenpox, for a long time, usually, makes a person **immune** from later attacks.

Typhoid fever can be prevented by the use of "typhoid vaccine." The **dead** germs of typhoid fever are introduced under the skin through a hollow needle of a small syringe, and at once the white blood cells attack and destroy them.

This operation is repeated, ten days apart, until the three inoculations have been given. A person so **immunized** is most certainly protected for a few years from an attack of typhoid fever.

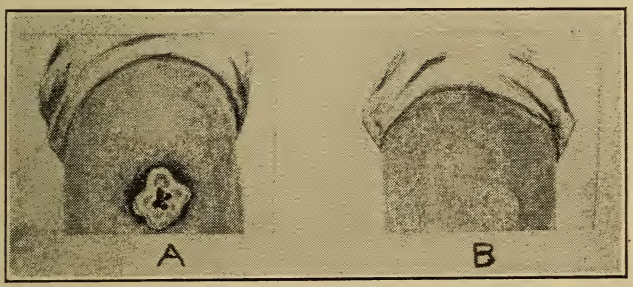


Fig. 66.—A. Smallpox vaccination. B. The scar. It is impossible for one so vaccinated to contract the disease for many years.

This disease in the Spanish-American War killed more of our soldiers than were killed and wounded in the war. In the great European War, in which millions of men were living under conditions which favored the spread of this disease, typhoid fever was almost unknown because every soldier was "immunized" against it.

Malaria is a disease which results from the growth and reproduction of tiny parasites in the red blood corpuscles. These parasites are introduced into the blood

stream in the saliva of a female mosquito, of a certain species, when she "bites" or stings a person in search of blood for food.

Fig. 67.—The female mosquito which, if herself infected, may give the disease to a person whom she "bites."

To be able to infect a person with malaria, she must have "bitten," some days previously, a person who was a victim of malaria and her own body must have grown and reproduced the malarial parasites.

These parasites are stored in the salivary glands of a mosquito. The "bill" of a mosquito is introduced through the skin of her victim and the saliva of the mosquito is used to dissolve the red blood corpuscles which are too large to be "sucked" through her bill. It is the acid saliva which causes her bite to sting and burn.

The parasites, thus introduced, at once seek and enter red blood corpuscles to make their home. In a short time many new parasites are freed into the blood stream and in a few weeks millions of red blood corpuscles are thus destroyed. The victim becomes pale, weak and "thin" and unable to do hard labor.

Fig. 68.—The black dots are the malaria parasites which have grown in a red blood cell. Many millions of cells may be thus destroyed during an attack of "chills and fever."

"Chills and fever" are the common form of this disease, although there are other forms of it in which the daily or "every other day" chills do not occur.

It is a serious disease and a

competent physician should be called, upon the appearance of such chills, who in addition to quinine or some similar drug, will give directions for the relief of the anemia and weakness and for protecting other members of the family or neighborhood from becoming infected.

Summary

Red blood corpuscles are one-fourth as thick as their diameter. By osmosis, oxygen is distributed to the body cells which by the same process convey their carbon dioxide to the red blood cells. In the lungs, carbon dioxide is exchanged by osmosis for oxygen, and the blood is said, for this reason, to be "purified."

Oxidation is "burning" of food with the exchange of oxygen for carbon dioxide in the tissues of the body.

Anemia is the loss of coloring matter in the blood and may be caused by loss of a quantity of blood or by destruction of red blood cells, as in a wasting disease.

The white blood corpuscles, fewer in number and larger in size than the red blood cells, are the "defenders" of the body against certain **pathogenic** bacteria. Their chief function is to carry food to the body cells, in the lymph.

They are present in large numbers when inflammation of tissues occurs, as in "boils," infected wounds, tonsilitis and like infections.

White blood cells are responsible for immunity against certain diseases.

Typhoid fever does not usually attack one who has been a victim of it or who has been immunized against it.

One may be "vaccinated" or immunized for typhoid fever at a small cost and it is a harmless procedure.

Malaria is a disease caused by living **organisms** which

destroy millions of red blood cells. It is carried only by the bite of certain mosquitoes, which are themselves infected. "Chills and fever" are the common name for this disease. It is curable and preventable.

Questions

1. What is the shape, size and number of red blood corpuscles? What becomes of them?
2. What is their function? How is it performed?
3. What is oxidation? What is meant by osmosis?
4. What is oxidation in the tissues?
5. What is anemia, and how may it be produced? How may one recognize an anemic person?
6. Why are white blood cells sometimes called the "wandering cells?"
7. What is their chief function? What other important use have they?
8. What is an inflammation? Give the **symptoms**, or signs, of an inflammation? Give three illustrations of an inflammation?
9. What are normal tissues?
10. Explain why "kernels" are produced.
11. What is meant by "blood poisoning?"
12. What is meant by immunity? Name five diseases which, after an attack, usually make one immune from subsequent attacks.
13. What is the only way to prevent smallpox? How successful it is?
14. How do civilized governments keep typhoid fever from destroying their armies? How successful is this procedure?
15. What reason would you give for not being made

immune from an attack of smallpox or typhoid fever by vaccination?

16. What is malaria? How does one become infected with malaria?

17. Why do mosquito bites "sting?" Why is it necessary for a mosquito to inject saliva into the body of a victim to secure its food? Under what conditions may a mosquito infect a person with malaria?

18. Where do malarial parasites grow? How numerous may they become?

19. What are the bad effects of malaria? What are "chills and fever?"

20. What should one do if malaria is present in the blood?

CHAPTER XX

HYGIENE OF THE CIRCULATION

Exercise. The action of the muscles of the body helps to maintain the circulation of the blood and lymph. A person who takes no exercise has a poor circulation and a low vitality. Oxidation is imperfect and the body cells do not crave nourishment as they should in one who is most efficient.

Such a person is usually pale, and will tire easily upon slight exertion. In sickness when reserve force is needed for recovery, a person who has failed to take proper exercise is much more apt to remain sick for a longer time, to be severely ill or die, than a person who is "physically fit" by reason of proper daily exercise.

Too much exercise, as in running, playing football, tennis, swimming or in any sports which require severe action of the muscles, may cause an enlargement of the heart so that its valves do not perform their function properly, and a "leaky heart" may result.

It is a good rule to stop hard exercise when one becomes "tired."

By careful training so that too great a strain is not placed upon the heart for too long a time, one may become accustomed to prolonged muscular exercise with no evil effects. In this case, the heart muscle becomes much thicker, larger and stronger. If one is compelled to retire to a quiet life, violent exercise should be gradually reduced so that the heart may adjust itself to the new condition.

Fresh Air. Good health depends upon good blood, and one's blood cannot be pure if the air that is breathed does not supply all the oxygen needed by the red blood cells.

Expired air coming from the lungs, contains carbon dioxide collected from the body cells. If a room be small and tightly closed, this gas is re-breathed into the lungs, and the red blood corpuscles cannot get rid of all their new load of carbon dioxide, nor can they collect all the oxygen they need for the body cells. They are forced to make their trips through the body with a scant supply of oxygen for hungry cells, and hour after hour, the oxygen becomes less plentiful and the carbon dioxide more abundant. After several hours the body cells rebel at this sort of treatment and a "headache," languid muscles, and a poor appetite voice their protest.

Sleep with the windows open, winter and summer, and protect the body from cold with suitable clothing.

Drugs for Headache. Many people think that a headache calls for a drug to relieve the pain. This is a mistake, for most headache medicines are weakening to the heart muscle and they may do great harm by forming a drug habit. Most of the headaches are caused by disobeying such rules of health as sleeping in the fresh air, proper eating or attention to regular functions of the body in ridding itself of waste material. If these errors are corrected, headaches will usually disappear.

Alcohol. The continued use of alcohol and whiskey, beer, wine or other alcoholic beverages, leads to serious results.

The heart becomes enlarged because alcohol causes it to beat more rapidly. Its walls may become hardened and its force is reduced.

The walls of the arteries usually become hardened and they refuse to expand and contract as they should do in health. This causes the heart to work harder to overcome the difficulty and a "leaky" heart may result.

The capillaries become enlarged and more blood pours into them. This is shown by the "drunkard's nose," which is caused by a congestion of the skin capillaries.

Blood vessels whose walls become hardened are more apt to burst or rupture than healthy ones, and **apoplexy** in heavy drinkers is common. This is a bursting of a blood vessel near the base of the brain with resulting paralysis.

Drinkers usually become heavier and a large amount of fat collects in different parts of the body, especially the abdomen and the heart. The heart's action is impaired for this reason.

The blood cells are injured by the continued use of alcohol and oxidation and assimilation are imperfect so that the whole body suffers as a result.

Hard drinkers usually have a great deal of difficulty in recovering from a disease which calls for a large reserve force, as in pneumonia or typhoid fever. Their heart and arteries are much more apt to fail at the critical turn of the disease.

Tobacco acts as a stimulant to the heart, which causes it to beat quicker and somewhat irregularly. After continued indulgence in the use of this drug, a "tobacco heart" may result. This condition causes a rapid, irregular and hard beat of the heart, and the use of the drug should be gradually discontinued. Cigarette smoking by young people is especially harmful.

Summary

Exercise is of vital importance in maintaining the character and quality of the circulation of the blood and lymph, and for building up a reserve force for use in severe and prolonged sickness.

Exercise may be overdone, by young people in their indulgence in sports. Moderation is the rule.

Good blood depends largely on plenty of oxygen being supplied to it. "Bad air" causes a headache by the "air hunger" of the body cells.

Indigestion, weakness and loss of vitality follow the continued habit of breathing air containing too much carbon dioxide.

Headache medicines should be avoided, and habits of correct living employed instead.

Alcohol, when its use is continued, has an injurious effect upon the heart, arteries, capillaries and blood cells. Vitality is lowered, heart disease is more likely to arise, apoplexy may follow the bursting of a blood vessel in the brain and inability to withstand the ravages of a severe illness are some of the consequences of the continued use of alcohol as a beverage.

Tobacco unduly stimulates the heart and may lead to an irregular, hard, quick, wavering action of the heart, known as tobacco heart. This is common in young people who have foolishly formed a habit of smoking cigarettes and "inhaling" the smoke.

Questions

1. What function do the muscles in action perform in relation to the circulation?
2. What is the effect of lack of exercise on the cir-

culation? What evil effect follows when proper exercise is not taken?

3. What evil effects follow over-exercising? How may one over-exercise? What is a safe rule when exercising?

4. If one has been in training for hard exercising, what danger is there if it is suddenly stopped? What rule should be followed if such a person retires to a quiet life?

5. What is the relation of fresh air to good blood? What is a common effect of breathing "bad air?" Explain how this is caused.

6. What is the rule for sleeping, as it relates to air for the blood?

7. Why should not drugs be taken to relieve headaches? What are usually the best "headache remedies?"

8. What is the effect on the heart of the continued indulgence in alcohol as a beverage?

9. What evil effects does it have on the arteries?

10. What effect has it on the capillaries? What is a "drunkard's nose?"

11. What is apoplexy? What is a frequent cause?

12. Who has the greater assurance of recovery from pneumonia or other severe illness, everything else being equal, the hard drinker or the person who does not use alcoholic liquor as a beverage? Why?

13. What is the effect of tobacco on the heart? What is a tobacco heart?

14. What are the evils of cigarette smoking by young people? Can you explain why "inhaling" cigarette smoke is most harmful?

CHAPTER XXI

THE RESPIRATORY SYSTEM

Breathing is one of the first acts performed when one is born into the world. It ceases, as the soul passes into eternity. Without "breath," we die. When one is seriously wounded, and is lying unconscious, one of the first things we look for is to see, if there is "breathing" or the act of respiration. If such a person is getting air into his lungs, there is life and, therefore, hope that recovery is possible.

Digestion and absorption of food are vital operations, and so is the circulation of the blood and the lymph, but if air (oxygen) is not supplied to the blood for the body cells, all other operations of the body cease and death ensues.

Object of Respiration. The purpose of respiration of air is to supply oxygen through the blood to the tissues of the body and to throw off the carbon dioxide from the body cells.

The food carried to the body cells by the white blood cells is oxidized (burned) by the oxygen carried to them by the red blood cells. Light a match and watch the flame. This is oxidation of the carbon of the wood by the oxygen of the air. Heat and energy are produced. So it is within the tissues of the body; the food is oxidized by the oxygen, and heat and energy are given to the body cells.

If respiration stops, there may be plenty of cell food in the blood for the tissues, but with no oxygen present, the change of food into flesh, heat, and energy will not

occur. Oxygen is the agent necessary to cause the food to be oxidized (burned) within the cells.

Respiration consists of two acts: **inspiration** and **expiration.** The air is taken **into** the lungs during inspiration, and it escapes **from** the lungs during expiration.

Organs of Respiration. The organs of respiration are the lungs, air passages, the chest walls and the muscles that help in the act.

The organs chiefly concerned in respiration are the lungs. In them the blood takes up oxygen and gives up its carbon dioxide. The air passages include the nostrils, the **pharynx,** the **larynx,** the **trachea,** the **bronchioles** and the **air cells** or sacs.

Fig. 69.—A typical adenoid face. A "mouth breather."

The nostrils of the nose are well supplied with blood vessels and have a large surface of mucous membrane which is kept moist with a secretion of mucous. Hairs are found at the entrance into the nostrils. Dust and other impurities in the air are thus sifted and most often caught before they reach the lungs. Cold air is warmed in the nostrils ready for its use by the lungs.

"Colds in the head" or "bad colds" are caused by the **inhalation** of certain germs that produce the disease. Sudden changes of temperature lower the resisting power of the mucous membrane of the nose to fight these invading germs, and a "bad cold" may result. Sitting or sleeping in a "draft" of air can only cause a cold if the body is not kept properly protected from cold by clothing, and it becomes suddenly chilled.

The **pharynx** is the opening in the back of the throat from the outlet of the nostrils above the **soft palate,** to the entrance into the larynx at the top of the windpipe.

The air passing through this space is warmed and further relieved of its impurities.

In the upper and on the back wall of the pharynx are sometimes found enlarged **adenoids.** These are spongy growths of loose tissue which may so obstruct the flow of air through the nose, as to force a person having adenoids, to breathe through the mouth. If this tissue is not removed, it may lead to serious consequences such as earache, defective hearing and anemia. The whole facial expression may be changed and the features be permanently deformed.

Adenoids are easily removed by a skilled surgeon and the operation is quite simple and almost free from danger, and should be done.

The **tonsils** are located in the pharynx on each side in front and below the outer margins of the soft palate.

The function of the tonsils is to filter material entering the lymphatics from the mouth, nose and pharynx, so that infectious matter may not enter the blood.

Often they become infected and enlarged. An inflammation of the tonsils is called **tonsilitis.** If the trouble persists and the tonsils become so large that they interfere with breathing, or cause earache or defective hearing or anemia, they should be removed by a competent surgeon.

The **Larynx.** The air after passing through the nostrils and pharynx enters the larynx, which is located at the top of the windpipe.

The **voice** is produced in this organ as the air passes out through the opening **(glottis)** at the top of the larynx

The **vocal cords** are not really cords but membranes which, by contraction of muscles, are made to close partly the glottis. The air forced between these "cords" causes them to vibrate and sound is produced. These sounds are regulated by control of the muscles and the voice is **modulated** or changed at will.

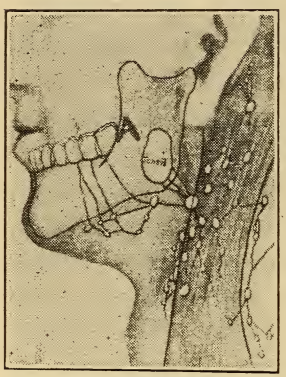


Fig. 70.—A. Showing the location of tonsil and its connection with the lymphatics.

The larynx has been well called the "voice-box."

The "Adam's Apple" is a projection in the front of the throat of part of the larynx.

Food and drink when swallowed must pass over the opening into the larynx. The epiglottis promptly closes this opening and the material is passed safely over the glottis. When it fails to operate promptly a bit of food or drink may be sucked into the larynx and at once there is violent coughing to force it out.

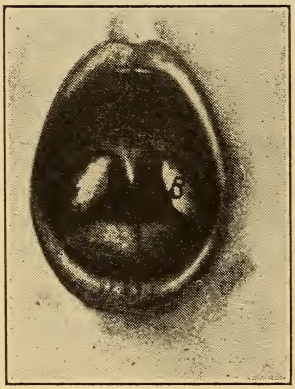


Fig. 71.—B. Diphtheria attacking the tonsils which are covered with a tough membrane.

The **trachea**, or windpipe, is a tube about one inch in diameter and about four and one-half inches long. It begins at the lower end of the larynx and ends in two branches, the right and left **bronchi**. It is kept from closing by horseshoe-shape rings of cartillage which do not quite complete the ring at the rear side. The bronchi continue to divide

like the branching of a tree, and such branches, beginning in the lung, are called **bronchial tubes.** The bronchial tubes further subdivide, and terminate in the **air-sacs** or cells of the lungs.

Summary

Respiration, consisting of the acts of inspiration and expiration, is one of the vital operations for maintaining life.

Its object is to furnish oxygen through the blood for the burning of food in the body cells and to rid the blood of its carbon dioxide.

The lungs, air pasages, walls of the chest and certain muscles are the organs of respiration.

The nose and pharynx filter and warm the inspired air. Adenoids and enlarged tonsils, when they interfere with respiration, should be removed.

The larynx is the organ of speech and is part of the air passages.

Voice is a sound made by the forced passage of air through the vocal cords, during expiration, which are made to vibrate by the action of controlling muscles.

The trachea is the windpipe and divides into two bronchi which, in turn, divide into bronchial tubes. Air sacs are the most distant division of the air passages.

Questions

1. What is one of the first and last acts performed by the human body?
2. What is the result, if one stop breathing? Why?
3. What are the two chief functions of respiration?
4. What is meant by oxidation of food in the body

cells? What agent is necessary for this to be done? Is there any relation between the burning of coal and oxidation in the tissues? What is it?

5. What is inspiration? Expiration?

6. Name the organs of respiration. What is the chief one?

7. What two functions of respiration have the nostrils? What is a "bad cold?"

8. What is the pharynx? What are its functions? What are adenoids? What harm may they do? What is the function of the tonsils? When should they be removed?

9. What is the larynx? What other name has sometimes been given it? What is the glottis? The epigottis? How may one become "strangled" on food or water?

10. What is voice? How is it produced? How is it regulated? What is the difference between a song that is sung and a scream? An ordinary conversation? What is the "Adam's Apple?"

11. What is the trachea? What is its length and diameter?

12. What are the bronchi? How many bronchi? What are the bronchial tubes? Into what do these terminate?

CHAPTER XXII

THE LUNGS

The chief function of the air passages, the walls of the chest and the muscles of respiration, is to keep a flow of air into the **lungs** and out of them.

The lungs are two in number, the **right** and the **left.** They occupy most of the space in the chest and weigh about three pounds.

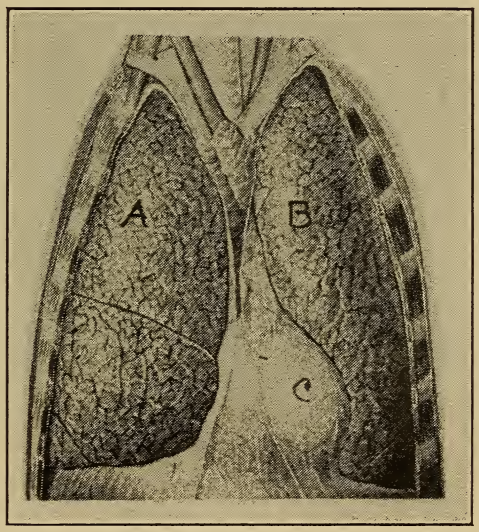


Fig. 72.—The lungs. A. Right lung. B. Left lung. C. The pericardium containing the heart.

The right lung is slightly larger and heavier than the left lung. Each lung is separated into sections or **lobes.** The right lung has three lobes and the left one has two lobes.

The division of the lung is one of nature's provisions to prevent such diseases as tuberculosis (consumption) and pneumonia from destroying or impairing a whole lung, when one part of it becomes infected.

Lungs are commonly called "lights" in animals killed for food, probably because lung tissue, under such circum-

stances, is filled with air and is so "light" that it floats in water.

The lungs are penetrated in every direction by the bronchial tubes, which branch from each bronchus, like the branches of a tree.

These tubes finally become so small that their branches may be likened to the twigs of a tree that send forth stems; and finally they end in the air sacs of the lungs. These air sacs are so small that about five million of them would be found in a pair of lungs, and if their walls could be spread out on a flat surface and placed together as in a "crazy quilt" or bed cover, their surface would be as large as a rug four feet wide and five feet long, or twenty square feet.

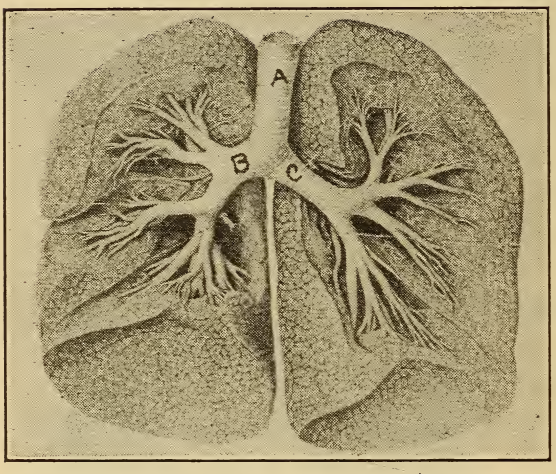


Fig. 73.—Showing the Trachea, A. Right bronchus, B. Left bronchus, C. and bronchial tubes as they subdivide from each bronchus. Note the rings of cartillage (gristle) in the largest tubes.

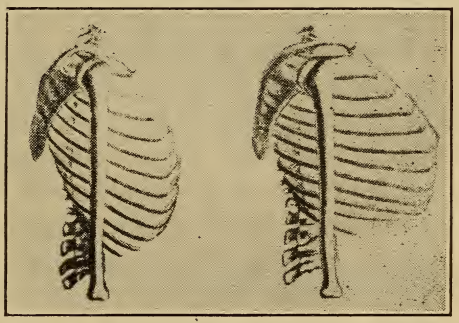
It is in the air sacs that the exchange of oxygen and carbon dioxide is made.

The lungs are covered with a smooth, velvety lining or cover called the **pleura.** The pleura also winds around and covers the inside surface of the chest walls.

The space formed by the ribs and breast bone (the sternum) in front, and the upper part of the "backbone" (spinal column) behind, is called the "thoracic cavity" and a cage or frame forming its walls is called the **thorax.**

The thoracic cavity is mostly occupied by the lungs and the heart.

The outer walls of the lungs lie in close contact with the inner walls of the thoracic cavity. The layers of pleura are, therefore, in contact and as the walls move to and fro, in breathing, the layers of pleura rub over one another. Nature provides a fluid to prevent friction and irritation of the pleura.



A B

Fig. 74.—A. The chest in expiration. B. The chest in inspiration. Note its increased capacity.

If an infection of the pleura occur, such an inflammation resulting is called **pleurisy,** and is exceedingly painful, because, with each respiration, the sensitive nerves are rubbed together.

How We Breathe. Force all of the air out of the lungs and hold "your breath" until you are forced to breathe. Notice what happens. The walls of the chest are raised and spread out; the back is straightened; the nostrils are opened a little wider, and something seems to "swell up inside."

The muscles between and overlying the ribs, raise the drooping ribs. A broad muscle, arched across the lower outlet of the thorax (diaghragm), is made to contract which pushes the stomach and bowels downward and this further

increases the space in the thorax. The lungs are made to follow the walls of the thorax, as more space is thus created, and the air rushes through the nostrils into the lungs exactly as it does into a bottle when the cork is suddenly pulled.

Now after drawing a full breath, hold it until you are forced to "let go." Notice what happens. The chest walls fall, the stomach and bowels seem to rise, the shoulders and back relax a little. The lungs which, when full of air were "on the stretch" like a piece of elastic rubber, now contract and the air comes rushing out of the nostrils, with a slight breezy sound. This is the act of expiration.

The Capacity of the Lungs. One wonders how much air the lungs will hold. In ordinary, quiet breathing only about thirty cubic inches of air pass into the lungs. In a forced respiration about one-hundred and thirty cubic inches of air can be inhaled and two hundred and thirty cubic inches or about one gallon can be exhaled. There always remains in the lungs between "breaths" about one-hundred cubic inches of air as a reserve supply for the blood during the intervals in the act of respiration. The total capacity of an average lung is about three-hundred and thirty cubic inches of air or less than one and one-half gallons.

Rate of Breathing. The average adult at rest breathes about eighteen times every minute; during and after violent exercise, the rate is much more rapid and the amount of air inhaled each time is increased, because the increased energy of the body calls for more oxygen to burn cells to produce heat and energy.

Summary

The lungs, two in number, are divided into lobes and are penetrated throughout by the bronchial tubes, which have their ending in the air sacs, where osmosis of carbon dioxide and oxygen occurs.

The pleura lines the surface of the lungs and the inner surface of the thorax.

Inspiration is performed by the action of the muscles which increase the capacity of the thorax by elevating the chest walls and depressing the diaphragm.

Expiration is performed by the contraction of the stretched elastic tissues of the lungs, when the muscles of the chest walls and the diaphragm are allowed to relax.

The rate of breathing and the amount of air breathed depend upon age, state of health, the employment, and habits of the individual.

Questions

1. What organs cause the air to enter the lungs and escape from them?

2. How many lungs has a person? What are they called? Where are the lungs situated?

3. What is the average weight of the lungs?

4. What are the lobes of the lungs? How many lobes in each lung? What is one reason for having lobes in lungs? What are "lights"?

5. Why does lung tissue, when it is cut across, look as if it were full of holes? Why are they of so many different sizes?

6. What are air cells? Where are they? How small are they? What would be their total area of surface if their walls were spread out in one sheet?

7. What takes place in the air cells of the lungs?

8. What is the pleura? Where is it? What is pleurisy? Why does not the rubbing together of the layers of the pleura cause pain in health? Why is there pain in pleurisy?

9. Name five things observed in a forced inspiration. Explain why these things occur.

10. Name five things observed when the air is expired. What is the cause of the air rushing out of the lungs during expiration?

11. How much air is breathed in ordinary respiration? How much may one, by effort, inhale? How much air remains at all times in the lungs? Why?

12. How many times a minute does a man ordinarily breathe? When is there faster breathing? Why? Can you explain why a sickness with fever causes a more rapid breathing? Why does a person become "thinner" during such illness?

CHAPTER XXIII

AIR

Composition of Air. Air is a mixture of gases, which may be separated from one another. It differs from a chemical **compound** like water, which is made up of two parts of hydrogen and one part of oxygen. These two **gases,** when mixed, form a new substance which is a **fluid.**

Air is composed, in the main, of nitrogen and oxygen, in the proportion of about four parts of the former to one of the latter. Carbon dioxide is present in about one-thirtieth of one per cent in pure air. Oxygen is easily extracted from air.

Place a tumbler over a candle, floating in water; light the candle and invert the glass over it until the edges of the glass touch the water. The flame burns all the oxygen in the glass; and the candle "goes out." Water is forced up into the glass and it will be noticed that the water fills it about one-fifth full to take the place of the oxygen.

Air Pressure. Air completely surrounds the earth and extends hundreds of miles toward the sky. Being a gas it has weight and on the earth, at the sea level, its pressure is near fourteen pounds to the square inch. On high mountain tops it is less, and at the great heights to which aviators ascend, the pressure is so much lighter that they frequently suffer great headaches or even faint. This is because man is constructed to live where the air pressure is great.

Air pressure can be demonstrated many ways. The sound made when water is poured out of a jug is made by the air pushing its way through the water to fill the space

that had just been occupied by water. The noise made by clapping the hands is produced by the air suddenly rushing in to fill the space made vacant by the sudden impact of the flat surfaces of the hand. The sound of thunder is made in a similar manner when lightning creates a **vacuum** or vacant area in the air.

The sound of breathing in inspiration in made by the inward rush of air to fill the vacuum that is made within the lung cells. The muscles of the thoracic cavity create a vacuum by enlarging the space which is filled by the lungs. The air pressure forces the lung to follow the expanding walls. If there were a large opening made through the ribs and pleura so that air might rush through this new opening as the ribs move outward, the lung would not expand and inspiration would be impossible.

Nitrogen comprises about four-fifths of the air. It is of no value when breathed except to dilute the oxygen needed in the body cells. Man cannot breathe pure oxygen and live long.

Carbon Dioxide is a gas found in small quantities in the air. It is a plant food.

Every process of oxidation, whether in the roaring furnaces or in the silent oxidation within the tissues of all air-breathing animals, supplies to the air carbon dioxide.

A man in every hour will exhale about seven gallons of carbon dioxide; a ton of coal, when burned, will produce about nine thousand barrels of this gas. The plants absorb this gas and use it for food, thereby producing starch, and as they work they give off our life-saving oxygen. Thus again do we see the intimate working relation between the animal and vegetable life, for not

only do plants help to furnish our food but while doing so purify and replenish our air supply.

Changes in Inspired Air. Air is warmed in its journey through the nostrils and air passages.

Upon reaching the air-sacs, it is separated by the circulating blood stream only by a single layer of cells. The red blood cells, laden with carbon dioxide from burned tissue cells, now give up this gas and receive in return the life-giving oxygen. The air also receives **moisture** or water. This may be proven by blowing the breath upon a cold mirror when the **vapor** is condensed and may be seen as water.

Inspired air contains a little less than four parts of carbon dioxide to ten thousand parts of air. **Expired** air contains about four hundred and thirty parts of carbon dioxide to the ten thousand parts of such air. Inspired air contains about twenty per cent oxygen. Expired air contains about fifteen per cent oxygen. The body needs can be maintained, if the supply of oxygen is about ten per cent so that air may be breathed twice without harm to the body.

Effect of Breathing Air With Insufficient Oxygen. Rebreathing the same air results in an increased amount of carbon dioxide, and causes one to become drowsy and mentally dull.

Children at school and persons at church get drowsy and inattentive, many times, because the air in the room has become too heavily laden with carbon dioxide.

Long continued living in rooms which permit the accumulation of this gas causes anemia, and general ill health with loss of efficiency.

A room is "close" or contains too much carbon dioxide if, when entering it from the pure air, it has a bad odor and a kind of "stuffy" feeling. The nose is a good agent to detect bad air.

Summary

Air, a mixture and not a compound, is composed mainly of oxygen and nitrogen in the ratio of one to four.

Inspiration is possible because of air pressure, which at the sea level is about fourteen pounds to the square inch. Nitrogen is inert and dilutes the oxygen so that the body cells may best use it.

Carbon dioxide is a product of combustion, or oxidation, and is a plant food for making starches.

Inspired air is warmed, moistened, filtered, and loses oxygen and gains carbon dioxide. Air rebreathed many times produces heaviness, weakness and mental dullness.

Questions

1. Explain that air is a mixture of gases and not a chemical compound.

2. Give an example of a chemical compound and tell its composition.

3. Of what is air composed chiefly? In what proportion are the gases formed?

4. How can the relative amount of gases be shown to exist in air?

5. Where is air found? How much does air weigh at the sea shore?

6. What difference is there in its weight, three miles high? How do great altitudes affect aviators at times?

7. Name three acts which demonstrate air pressure. What is a vacuum?

8. Why does air enter the lungs when the walls of the thorax are lifted by the muscles of inspiration? Which

exerts the stronger force in this act, the air pressure or elastic lung tissue? Why?

9. What is the use of nitrogen in respiration?

10. What is carbon dioxide? How is it produced? How much will a man produce every hour? How many days would he have to live to oxidize as much material in his body cells as is represented in a ton of coal burned?

11. How are starches in plants made? What gas is given off when starch is thus produced?

12. Describe what is meant by the "intimate working relation between the animal and vegetable life?"

13. Name four changes that occur in inspired air.

14. How many parts of carbon dioxide in ten thousand of air does inspired air gain during inspiration? How many per cent of oxygen does air lose during respiration? What is the lowest per cent of oxygen which air may contain and be sufficiently pure to meet the body's needs?

15. What is the effect on the body of rebreathing the same air? What effect on the mind? Why do people sometimes "go to sleep in church?"

16. What organ of the body makes a good detective to discover air with too much carbon dioxide? What does it discover in such air usually?

CHAPTER XXIV

VENTILATION

Quantity of Air Needed. An average man who is not engaged at physical labor requires about 3,000 cubic feet of fresh air every hour; a child of twelve about one-half as much.

School houses and public buildings should contain 600 cubic feet of space for each person who occupies them.

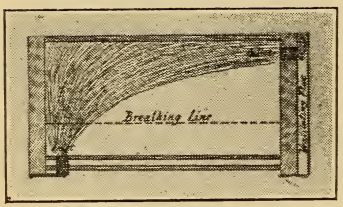


Fig. 75.—Showing imperfect distribution of air when the inlet for fresh air is on the floor line and the outlet is at the ceiling farthest away.

During the heated months an abundance of fresh air is admitted through the doors and windows of most houses. In cold weather windows and doors are kept tightly closed to keep a room or building heated for protection against cold. People living in such places are often compelled to breathe and rebreathe the same air which soon becomes laden with carbon dioxide and bad odors. Some means of ventilation must be provided.

Ventilation is a process by which impure air may be removed from closed places and fresh air be made to take its place.

Methods of Ventilation. In modern churches, large school buildings and office buildings, a **ventilating system** is usually installed. By means of revolving fans fresh air, heated or cooled to the proper temperature of 68° F. is forced through large pipes into each room and another set of pipes is made to take stale air out of each room.

The simplest method of ventilation is by the raising and lowering of windows in a room. Warm air, being lighter than cold air, will rise and if the air outside of the room is colder than the air inside, the warm air passes out of the windows at their top and cold air comes in below.

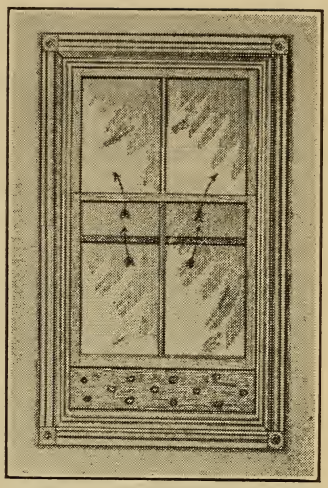


Fig. 76.—A means of ventilating in cold weather by lowering the top sash and raising the lower one and placing a board in the opening below the lower sash.

In winter time the rush of cold air into a room creates a draft and persons sitting too close to it may become cooled too suddenly. To overcome this, a board may be placed at an angle on the bottom of the window which will direct the flow of air upwards where it mixes with the warmer air of the room, or a board may be placed under the raised sash to close the entire space and the cold air allowed to enter the room only between the upper and lower sashes.

School Room Ventilation. In large, properly built school houses the architect usually includes in his plans a provision for the proper heating and ventilation of the building. Fresh air ducts and inlets for each room and foul air outlets from each room are made to operate so that an even temperature

Fig. 77.—Showing defective method of ventilation by placing the air inlet midway between floor and ceiling and outlet at ceiling at opposite end of room.

and a plentiful supply of pure air are furnished constantly.

The air in small school rooms, heated by stoves, frequently becomes very warm and foul when the windows are tightly closed. A steel jacket may be placed entirely around the stove leaving several inches of space and fresh air may be conveyed through a pipe from outside the building to the inside of the jacket below the fire-bowl.

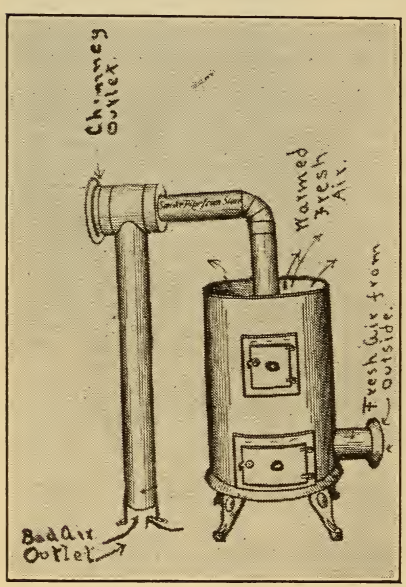


Fig. 78.—Illustrating the method of ventilating a room with a stove-jacket and air ducts.

Air entering this pipe is at once heated as it rises and it is mixed with the air in the room as it escapes from the top of the jacket. Another large pipe is arranged to connect with the chimney to carry foul air out of the room. Its lower end should rest on legs fastened to the floor near the chimney. Its upper end should be inserted in a drum or jacket which fits into a hole in the chimney which is a few inches larger than the smoke pipe from the stove. The smoke or stove pipe should run through this drum into the chimney.

The foul air which settles to the floor would thus be drawn through this pipe by the rising heat and smoke in the chimney from the stove pipe and escape with it.

If a school room is not provided with some arrange-

ment for its proper ventilation, frequent recesses should be given and for a few minutes windows and doors should be opened wide to admit an abundance of fresh air.

A sensible method to ventilate such a school room is to open every window and have the doors swung violently to and fro. The pupils during this period should stand in their places at the desks and engage in some simple stretching exercises of their muscles. Fresh air would quickly enter in abundance and any danger from drafts would be overcome by the stimulation of the circulation by the exercises.

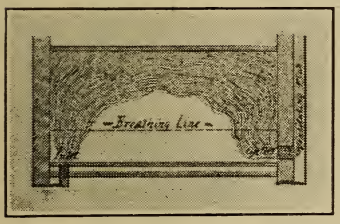


Fig. 79.—Showing the imperfect distribution of fresh air when the inlet and outlet are placed at the floor on opposite sides of the room.

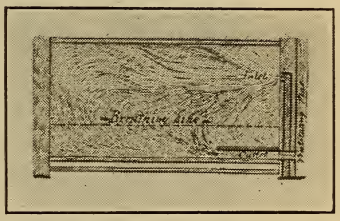


Fig. 80.—Showing the best way of ventilating by placing the inlet midway between the ceiling and floor and the outlet at the same end of the room near the floor.

Many times pupils who are dull and listless because of the foul air in a close room become at once alert and perform their duties much better.

The sloping board may be employed in many school rooms, and the upper sashes should be lowered a few inches. In extremely cold weather it may be necessary to close the space above the upper sash and use only the tight-fitting board below the lower sash.

In very cold weather, air enters in good quantities through cracks in walls and around windows and doors.

Sleeping Room Ventilation. People have begun to

learn that fresh air, like pure water, is one of nature's richest blessings to maintain health and prevent disease, and that both are free for their seeking. For many years,

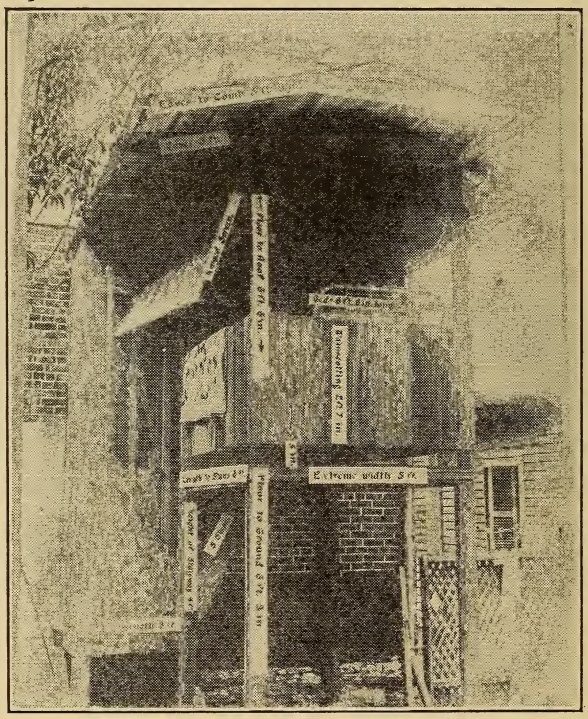


Fig. 81.—An outdoor sleeping porch connected by a stairway to a down-stairs living room, screened and protected by an over-hanging roof from sun and driving rains. The six-foot elevation and the wainscoting protect a female occupant from fear of intruders. The screen on hinges at the left side allows bed clothing to be sunned and "aired." The space below the wainscoting prevents the collection of carbon dioxide gas and insures a free circulation of air. In extremely cold weather or in a driving rain or a drifting snow, curtains may be placed around part of the porch. The cost of such a porch need not exceed $25.00.

it was taught that "night air" was dangerous and one was more liable to be ill if sleeping was done in night air. Now we know that to sleep out-of-doors at night, prop-

erly screened from mosquitoes and protected from cold, is the ideal way to furnish the body cells with oxygen while the body is resting and being rebuilt after the day's work.

Sleeping Porches are now being built in nearly every modern home. An upper porch connecting with bed rooms is so constructed that there is privacy; flies, mosquitoes, and insects are excluded by screening. In cold weather, one may undress and prepare for sleeping in a warm living room and enter the sleeping porch through a window or door. A woolen helmet is worn over the head and ears and around the neck, leaving an open space for the eyes, nose, and mouth.

Woolen blankets are tucked about the bed so that cold cannot enter and one may sleep in comfort in the coldest weather. Children and "weakly" people may need hot water jugs or "pigs" filled with hot water, placed under the blankets near the feet to help keep the body warm.

If a sleeping porch cannot be used, the windows in the sleeping room should be opened, winter and summer, to permit plenty of fresh air to enter.

Summary

The quantity and quality of air for the body is as important a matter as the quantity and quality of food.

Ventilation is a method employed to furnish enclosed spaces with fresh air and remove the foul air. In large modern buildings, ventilation is done by means of fresh and foul air ducts through which air is forced by revolving fans.

In cold weather, the flowing of currents of air by reason of the difference in temperature is the ordinary and sim-

ple method of ventilating homes, small school houses, and the smaller public meeting places.

A jacketed stove with a fresh air intake and a foul air outlet is a fairly good means of ventilating small school houses.

Windows should be raised and lowered for free circulation of air when the weather permits. Sloping window boards can be used in cold weather to prevent drafts when fresh air is admitted through windows.

Fresh air during the period of sleeping is vitally important. Sleeping porches, properly screened and adjoining a warm living room, are ideal for winter and summer use.

Questions

1. How many gallons of fresh air does an average man require every hour, if he is not doing hard labor? How many cubic feet does a boy of twelve years need every hour?

2. If your school room, inside, is thirty feet long, twenty feet wide and ten feet high, how many pupils may live in it, giving to each six hundred cubic feet of space? If sixty pupils are in a room ten feet high, and sixty feet long, how wide must it be to give each pupil the proper amount of space?

3. When is there most difficulty in furnishing plenty of air? Why?

4. What is ventilation?

5. How are properly built, large office buildings and school houses ventilated?

6. What is the simpliest way to ventilate a room?

7. Why does warm air rise? On a summer day when

no breeze is blowing, if a window in a school room is raised, will the air rush in the open window? Why?

8. How would you arrange to permit fresh air to enter through a window in cold weather so that a draft might not blow on persons sitting near by?

9. How may a small school room be ventilated with a stove-jacket? Why should the fresh air inlet be placed below the fire bowl of the stove? Why should the foul air outlet pipe extend nearly to the floor? Why could it not run out of the room through the wall instead of the chimney? What is the reason for this pipe running into a drum through which the stove smoke-pipe runs?

10. If a school room has no provision for ventilation, how should fresh air be supplied? What is the advantage of swinging doors in attempting to ventilate a room? If pupils are not given a recess, why could they not sit still in their seats while windows and doors are open to admit fresh air? What are the advantages of exercising while ventilation is being done?

11. What is the difference between "night air" and "day air"? Is night air healthy? Why? Where should one sleep? Where should sleeping porches be built? Why? Why should they be screened? How may one sleep "out-of-doors" in a sleeping porch and keep warm?

12. How should the sleeping room be ventilated? During what seasons of the year should sleeping porches be used? Why?

CHAPTER XXV

HYGIENE OF THE RESPIRATORY SYSTEM

Dust in Air. Nature has made wise provisions for keeping particles of dust and like impurities from reaching the delicate walls of the air-sacs. The hairs and the coating of mucous in the nose, the winding passages through the air ducts leading to the lungs, catch most of the dust.

The bronchi, and the bronchial tubes are lined inside with mucous membrane, on the surface of which and projecting into the air passages, are tiny waving arms (cilia) which always direct their motion towards the mouth. Under the microscope these cilia remind one of a waving field of wheat and tiny particles are seen being pushed along as if they were directed by reason.

The function of **cilia** is to clear the air passages of dust, germs and other foreign matter.

Dust is nearly always present in the air. A stream of sunshine in a darkened room reveals thousands of particles of dust.

In dry seasons, dust becomes abundant in the air.

In certain trades, as stone cutting, dressing lumber, working in cotton mills, a great deal of dust is always present in the air where people are employed. They should wear protectors over the nose and mouth, which are so made that all the inspired air has been sifted and almost freed from dust.

Housewives or others who sweep homes and public buildings should avoid "making a dust" while they "clean" the rooms.

A vacuum cleaner, which sucks the dust from the floor,

is the best means of removing the dust. A "carpet sweeper" is excellent, for the dust is immediately gathered into a dust-proof box which is part of the machine.

Oiled sawdust, or wet bits of paper, strewn over the floor and swept up gently may be used to avoid dust.

The use of a dry broom on dry floors is very objectionable, and dust, instead of being removed from the room, is scattered largely over tables, chairs, books, and elsewhere about the room.

"Dusting" a room should be done with a soft cloth wrung out of hot water to which a little "coal oil" has been added.

Rooms occupied by a person ill of tuberculosis, influenza, diphtheria and like diseases should never be swept with a dry broom.

Street dust in cities is dangerous for it is more apt to contain certain germs that can produce disease.

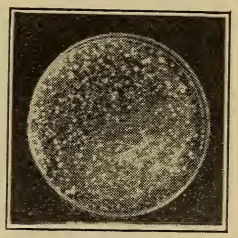


Fig. 82.—Colonies of germs grown on gelatin in a saucer which had been exposed to street dust for half an hour.

Gases in the Air. Air often is mixed with coal smoke, especially, in manufacturing centers. This is injurious to the lungs and general health because such air may contain the gases of coal and are absorbed with oxygen into the blood cells.

Many modern cities now require all coal-burning factories to use "smoke consumers."

Certain trades, as in the manufacture of chemicals, matches, etc., expose the workers to noxious or poisonous gases. Masks should be provided and their use made compulsory to protect the delicate air-cells and to prevent the absorption of such gases into the blood.

Sewer gas often escapes from defective plumbing into

living rooms and offices. Not only is it disagreeable to the sense of smell, but such gases, when breathed for some days or weeks, may cause serious changes in the quality of the blood with resulting loss of weight, anemia and loss of energy.

Exercise and Air. Exercise of the body muscles quickens the action of the heart, which pumps with more force; the blood circulates more rapidly; body cells burn more oxygen and heat and energy are increased. The breathing is fuller and more rapid to supply enough oxygen to meet the increased demand of the cells.

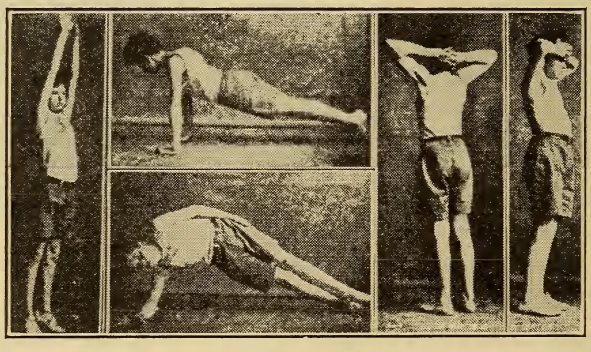


Fig. 83.—Showing stretching exercises that may be taken upon rising in the morning.

Exercise should be taken in the open air to get the most benefit from it. The outdoor sports are of great value for this reason.

Upon rising in the morning, the muscles of the arms, chest, legs, and abdomen should be exercised for ten minutes by stretching, bending, squatting, turning and lifting motions. The windows should be opened wide.

Tight Clothing about the waist or chest is to be avoided, because it interferes with deep breathing and permits a too limited supply of air for the blood cells.

Tight corsets are doubly injurious because not only are the lungs compressed and the air supply decreased, but the circulation of the blood through the digestive organs is hindered and it interferes with the important duty of nature for relieving the body of its wastes.

Postures. The lungs operate best when the chest is not restricted in its movements. One should walk erect with the back straightened and the shoulders thrown back and head erect. This allows free movements of the chest during respiration. When sitting at a desk, the back should not be curved and the shoulders allowed to droop. The seat of the desk should not be too high or too low.

School desks should be so constructed that the desk may be changed to fit the child, and not of one size and rigid, so that the child may be grown crooked to fit the desk.

During sleep, the head should not be raised too high by the use of pillows. The body should be kept as nearly as possible in its normal line.

Fig. 84.—Squatting exercise to exercise muscles of leg and back.

Alcohol weakens the resisting power of the body to disease. Some of the alcohol that is taken into the body cannot be oxidized and is thrown out of the body through the lungs as a vapor. The odor of whiskey can be smelled "on the breath" of one who has taken too much whiskey.

Habitual drinkers are particularly liable to colds, la grippe and pneumonia.

The death rate from pneumonia among those who drink to excess is very much higher than in abstainers.

It was a common belief that whiskey was good for colds and la grippe, and that its use would prevent such diseases. This made a very good excuse for people who craved alcohol, but it has no truth in it.

By lowering the resistance of the body cells, it may increase one's chances of becoming ill of these and other diseases.

Tobacco. Tobacco smoke is irritating to the delicate mucous membrane of the air passages and, for this reason, sore throat, hoarseness and colds are common among smokers.

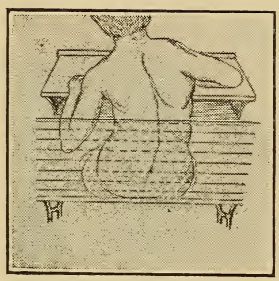


Fig. 85.—Showing harmful posture caused by sitting at a desk too high.

The "inhaling" of cigarette or cigar smoke is especially harmful because it seriously hinders the work of the air cells in the exchange of gases with the blood cells. In addition, cigarette smoke is readily absorbed by osmosis and the poison is taken at once to the tissue cells and impairs their usefulness.

This is shown after a few years' use by "nervousness," a "tobacco heart," a cough, anemia and generally lowered vitality.

Summary

Dust from the streets, and other sources is ever present in the air. It is hindered from reaching the air-sacs of the lungs by the functions of the hairs of the nose, the mucous membranes of the nose and throat and the cilia of the air passages.

Gases from the sewer, coal smoke and the manufacture of certain chemicals act as a poison when absorbed into the blood from the air when breathed.

Exercise in the open air, as a daily habit, is conducive to good health and greater efficiency.

Clothing worn too tightly interferes with proper respiration, as do wrong postures of the body when walking, sitting, or sleeping.

Alcohol lowers vitality and increases the number of fatalities of pneumonia in chronic drinkers.

It is not a preventive for colds and does not cure cough or la grippe.

Tobacco is an irritant to the mucous membrane of the air passages, and its smoke, when inhaled, poisons the body cells and interferes with their work.

Questions

1. What three provisions has nature made to free the dust from the air before reaching the air cells? What are cilia? What is their functions? How do they operate?
2. Name several trades which produce dust? What protection should the workers employ?
3. What is the best way to "sweep" a room? What is the worst way to do it? What effect does oiled sawdust on a floor have when it is being swept? How should a room be dusted to avoid "raising" a dust?
4. Why is street dust, especially in larger cities, dangerous?
5. Why is the inhalation of coal smoke injurious? How can a city become "smokeless"?
6. What danger is there in working in match factories and some chemical works? How can it be avoided?
7. What is sewer gas? How may it reach the living or sleeping rooms? Why is it harmful when breathed for a number of days?

8. Name four effects of exercise? Why should exercise be taken in the open air? What are good bedroom exercises? When should they be taken?

9. What bad effects has the wearing of tight clothing? Why are tight corsets injurious?

10. What is the effect on respiration of a stooped posture? How should one walk with reference to a proper supply of air? Sit? Sleep?

11. When an excess of alcohol is drunk how is some of it eliminated? What happens to it in the tissues? Why are habitual drinkers more liable to the disease of the respiratory organs? Is whiskey a good preventive of colds? La grippe and pneumonia? Why?

12. What is the effect of tobacco on mucous membranes of the air passages? Why is the inhaling of cigarette smoke especially harmful? What conditions finally develop as a result of continued and excessive use of cigarettes?

CHAPTER XXVI

INFLUENZA AND "COLDS"

Germs in the Air. The air under certain conditions may convey many forms of germ diseases from those who are sick to healthy persons and produce in them like diseases. Among these are "bad colds," influenza, pneumonia, diphtheria, scarlet fever, and whooping cough.

"Bad colds" are, perhaps, most frequently so carried. This disease is an inflammation of the mucous membrane of the nose, and is caused by the growth of germs. A person with a cold may sneeze and by doing so, if one has not learned to cover his nose and mouth with a handkerchief, the germs of his disease may be sprayed through the air several feet in the direction in which his nose is pointed. These germs may be at once inhaled by another person, and, if conditions are favorable for their growth, they will begin to multiply in the new nose and another "bad cold" is the result. The danger of colds is in the frequency of their bad ending—in bronchitis, pneumonia, or inflammation in the ears.

Influenza, sometimes called LaGrippe, Spanish Influenza, "The Flu," is a disease spread like "bad colds" almost entirely by careless coughing, spitting, sneezing and talking. At times it spreads with great rapidity, at which time it is said to be **epidemic.**

This disease in the later months of 1918 killed more than 200,000 people in the United States, and many millions were made ill. It began in Spain and followed the routes of travel, reaching New York first, and spreading rapidly over the Eastern, Southern, Northern, and West-

ern parts of the United States and into Canada and Mexico. Schools were closed. Doctors were not able to visit many who were seriously ill, and nurses were too few to wait on the sick. Whole families often were in bed at one time.

This is a typical germ or seed disease and the germs were carelessly coughed, sneezed, or spit about, so that well people who were unfortunate enough to come near such people or places, where they had been, were at once infected.

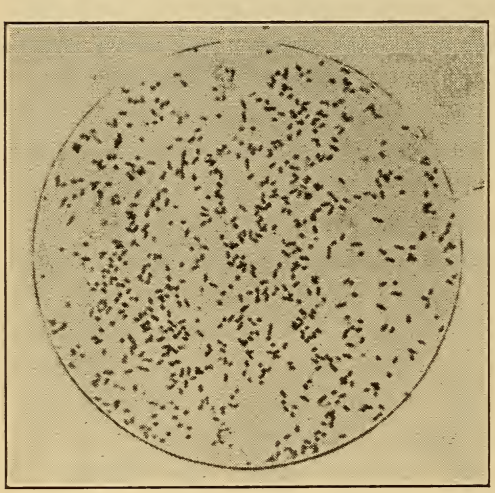


Fig. 86.—The germs of influenza.

If every person who was ill of influenza had known what this book teaches concerning the spread of diseases and their prevention, and had applied that knowledge, this disease would have been confined to the first cases.

Influenza begins with aching pains in the muscles, some headache and fever, a mild cough and a feeling of weakness.

In mild cases, recovery is rapid and free from after-effects except a feeling of continued weakness. Most cases are mild and for this reason it has been called "Three-day Flu." In the severe cases, pneumonia and pleurisy often develop with frequent deaths. On the

first appearance of the signs of the disease, the person should go to bed and send for a good physician.

A person having influenza should not cough or sneeze except into a handkerchief, which should be kept moist with a five per cent. solution of carbolic acid. Eating utensils, as knives, plates, cups, forks, glasses, and spoons, after being used by the patient, should at once be well boiled.

The victim should be placed and kept in a room alone, except for the one who is doing the nursing, until every sign of the disease has disappeared. Bed clothing used by the patient should not be used until it is sterilized either by boiling, the use of chemicals, or long exposure to sunlight. Visitors should be denied admittance.

Prevention of Influenza. When an epidemic of the disease appears, people should stay at home; avoid crowds of people and crowded cars, churches, theaters, and other public meeting places.

Fresh air in abundance in the living and sleeping rooms should be supplied. Exercise and regular hours for the body's habits and for eating and sleeping must be practiced.

Alcoholic liquors are useless as a preventive and may be harmful by lowering the resistance of the body to infection.

Beware of the man who sneezes and coughs at you. His is a dangerous weapon and his charge spreads like a load of bird shot. About five feet is the limit of his range.

If one develops the "Flu" no alarm should be felt for its death rate is low when compared to the entire number who are ill, and the death rate is probably higher among

persons who foolishly allow themselves to become frightened.

Upon the appearance of a slight cold, which may be the beginning of influenza, the nose should be cleansed with a warm solution of common salt in water—a teaspoonful to the pint of water. This may be done with a spray, or by holding a bit of the solution in the hollow of the hand and "sniffing" it up the nose repeatedly. At intervals of two or three hours it may be repeated. "Dobell's Solution" can be used in the same way and may be purchased at any drug store. A hot bath at night and a warm bed with plenty of fresh air in the sleeping room are excellent aids in the prevention of this and like diseases.

Every citizen should obey the rules and regulations of the health authorities for prevention of the disease and insist that others do so.

Summary

Many diseases of the air passages result from the inhalation of the germs or seed which produce them.

Infections of the nose are the commonest example of the spread of such diseases by careless spitting, coughing, sneezing, or talking.

Influenza is a common infection in the United States, and ordinarily, is of a mild type. In epidemic form, its complications bring disaster.

Influenza, in epidemic form, can only be controlled by the united effort of all the people who know how to prevent its spread and who help to do it.

Crowded places, over-heated houses, poorly-ventilated sleeping rooms, poor food, intemperance, and irregular

hours are favorable for the spread of this and like diseases.

Questions

1. Name six diseases that may be spread at times by inhalation of germs in air? Why?

2. What is a "bad cold"? What causes this disease? How would you protect other members of your family or school-mates from this disease, if you had it?

3. What danger, if any, is there in "bad colds"?

4. What other names are given to influenza? How is it spread? What is an epidemic of the "Flu"? What can you say of the epidemic of 1918?

5. How does influenza affect one at the beginning? How long does a mild case usually keep one ill?

6. What serious complications sometimes follow in an attack of influenza?

7. What is the first thing to do when this disease develops? What precaution should be taken by the patient when he sneezes or coughs?

8. How much carbolic acid should be stirred into a quart of water to make a five per cent. solution?

9. Why should a victim of influenza be kept **isolated** or alone? What should be done with a patient's clothing and bed-covering before they are used by anyone else?

10. Why should crowds of people be avoided when an epidemic of influenza is present in a community? What is the most abundant, cheapest and one of the best preventives of influenza? When and where should it be used? What body habits should be practiced as a safeguard against the disease?

11. Is alcohol, as in whiskey, beer, or wine, a preventive of la grippe? Why?

12. Why and when is an unguarded sneeze or cough of a "Flu" victim dangerous?

13. How may a "cold" or a beginning attack of influenza be treated with benefit? What cleansing fluids may relieve such an attack? How should they be used?

14. What is the value of hot baths and fresh air in sleeping rooms during an epidemic of influenza?

CHAPTER XXVII

TUBERCULOSIS

Frequency of Tuberculosis. Tuberculosis or "consumption" kills about one of every seven people in the civilized

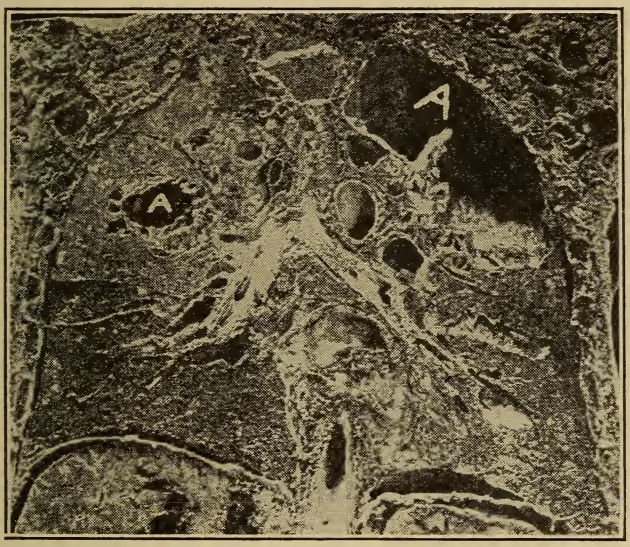


Fig. 87.—Showing great destruction of lung tissue from tuberculosis. (A.)

world. So destructive is it, that it is well called the "Great White Plague."

So general is it that it is presumed that nearly everybody, some time in life, has been infected with tuberculosis, many getting well without ever knowing of their having it.

In the dissecting rooms of medical colleges and large

hospitals, thousands of lungs have been carefully examined after death and infections of tuberculosis have been found in about eighty per cent. of all the lungs examined. Many of these people had died from other causes and most of the spots or areas of infection had been healed or made harmless.

As only about fourteen per cent. die of this disease it is readily seen that the great majority of people recover from its attack.

Fig. 88.—Tubercle bacilli—the germs growing in the walls of an air-sac.

Site of the Disease. Tuberculosis may attack the bones, brains, intestines, glands, lungs or any tissue of the body. The most frequent site of attack is in the lungs, where it is commonly spoken of as "consumption," or "weak lungs."

The Cause of Tuberculosis. Until 1880, the cause of tuberculosis was unknown. Dr. Koch, in this year, showed that in every case of tuberculosis there was present a tiny rod-shaped seed or germ; that this germ, if introduced into a healthy animal, like a dog, cat or guinea pig, would reproduce in a few weeks a like disease in such animals; and that this germ was never found in any other disease except tuberculosis.

This germ is a bacillus in shape and is named the **tubercle bacillus.** It grows like other germs, in the presence of food, warmth, moisture and in the absence of sunlight. It is so small that many thousands of them grouped together, could not be seen with the naked eye yet they have been grown

in laboratories in such numbers that one lump of them weighed a pound.

No one can develop "consumption" unless this germ or seed is planted in the body.

Tuberculosis is the result of the growth in the body of germs or seed of the disease, just as a stalk of corn is the result of the growth of a grain of corn planted in the ground.

Conditions must be favorable for the growth of the germs in the body, else they die, just as conditions of weather, soil and moisture must be favorable for the growth of the seed of corn in the ground.

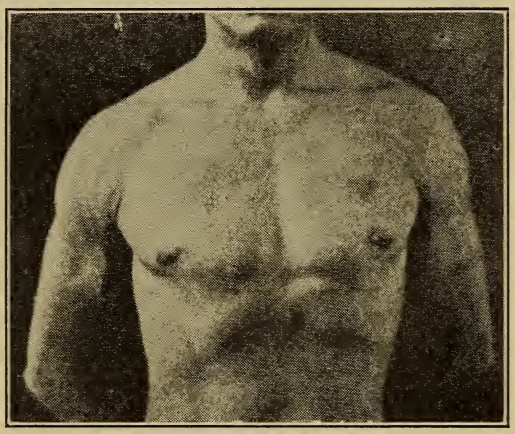


Fig. 89.—A strong, healthy pair of lungs with a full, devleoped chest.

If consumption germs would grow and produce the disease every time they get into the body, the human race would have died long ago. Such germs and many others are prevented from growth by the resistance of the body cells through immunity, and the action of the white blood cells which try to destroy them.

The Signs or Symptoms of Tuberculosis. Tuberculosis should be recognized early in its course for it is in this stage that it is most easily cured. Its presence in the body

gives rise to certain signs or symptoms which will lead one to consult a competent physician.

One of the early signs noticed is a **loss of weight.** In a period of several weeks, one may lose ten or twenty pounds for no apparent reason. The **appetite** is probably "fickle," some days one is very hungry and, again, there is little or no appetite for food.

A little **fever** appears nearly every day, especially, in the afternoons, and its presence will be shown by flushed cheeks or the "hectic flush." The use of a physician's **thermometer** each day will establish the fact of fever.

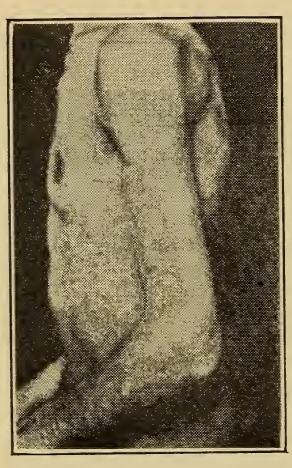


Fig. 90.—A consumptive who has lost weight. Note the thin chest.

A slight, hacking **cough** appears, which is most in evidence upon rising from sleep. After some effort, a bit or "plug" of mucous may be coughed from the lungs. This should be collected in a clean, wide-mouth bottle and sent to a laboratory, where the microscope may reveal the presence of the seed or germ of the disease.

If the germs are found, it is a final and positive proof that the one coughing up such material has tuberculosis. If the report states that the germs were not found, it is not final proof that one does not have the disease, because there may not have been any germs in that particular bit of mucous, and other specimens should be sent for examination.

Examination by a Physician. A competent physician when asked to make an examination of tuberculosis, will not ask a few questions, "look at the tongue" and

write an order for medicine, but will remove the clothing from the chest, and make a careful **physical** examination.

A physical examination of the chest will show a difference, if any, in the size of each side in inspiration; the presence or absence of any peculiar cracking or bubbling sounds in the air tubes; the change in voice sounds, if the disease is present; the presence or absence of cavities or "spots" in the lung; any change in the shape of either side of the chest; shallow or deeper breathing on one side or the other, and many other points which to the trained doctor may mean the presence or absence of tuberculosis.

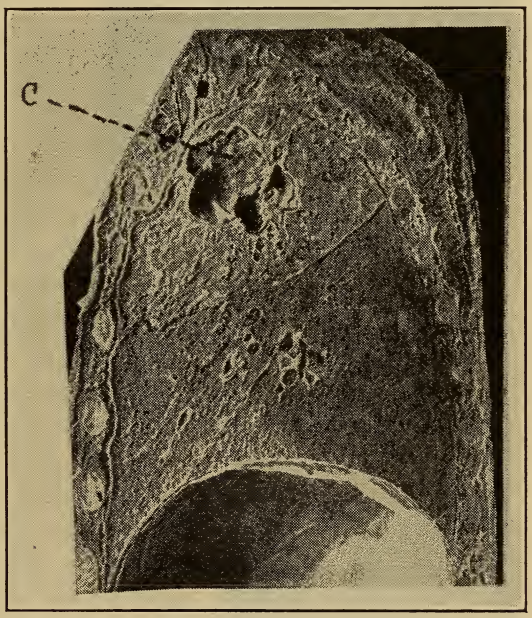


Fig. 91.—A cavity in the upper lobe of the lung, caused by the growth of tubercle bacilli. (C.)

A physician will cause the "temperature" and weight of the body to be recorded daily for several weeks, and will make many inquiries to learn if one has been closely associated with a tuberculous victim or if the disease "runs in the family."

Heredity of "Consumption." It was thought for a long

time that tuberculosis was inherited from parents to children. It is now known that this is not true.

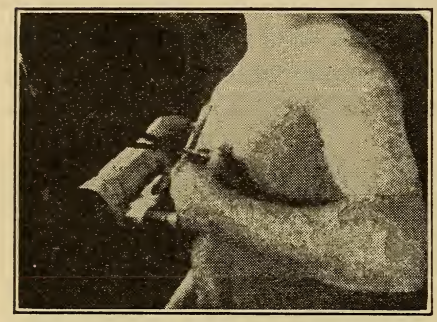


Fig. 92.—Listening for unusual breathing sounds—part of a physical examination.

Tubercular parents are usually not very "strong" and often have low vitality. Their children naturally are, as a rule, "weakly" and lack resisting power, and, for this reason, more likely to develop the disease, if the germs or seed find their way into their bodies.

A new-born baby may have a mother, who has "advanced" tuberculosis, or be in the "last stages" of the disease, but the lungs or other tissues of the baby, when born, are always free from the germs of the disease. Unfortunately, most mothers do not know how to prevent the spread of this disease and the baby often becomes infected in the early days of its life.

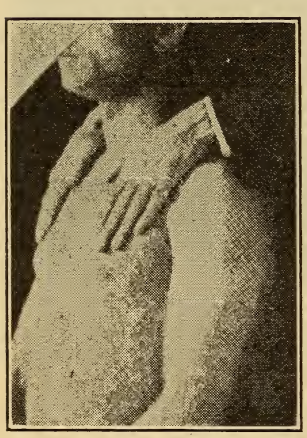


Fig. 93.—Feeling for unusual vibrations from the victim's voice in a physical examination.

How the Disease Spreads. The germs of consumption are often destroyed by white blood cells in the lungs. The attacking germs attempt to grow in the warm, moist, dark lungs, which furnish them plenty of food. At once the alarm is given and nature sends out her army of "policemen," the white

blood cells, and a great fight to the "last man" occurs. If the white blood cells are the victors (and they are in the great majority of "fights" or infections), the lung tissue becomes normal or well.

If the germs are numerous, persistent and strong, the lung cells are "broken down" or destroyed, as the army of white blood cells is forced farther away from the scene of the first attack.

These infected "spots" become large enough to be seen with the naked eye and the fight continues or stops depending on the strength of the opposing sides.

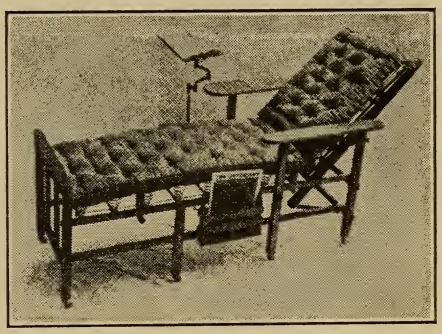


Fig. 94.—A reclining chair commonly used by consumptives for rest and comfort.

Often these spots, or infected areas, become as large as a marble, a plum, or an apple and the white blood cells succeed in limiting the spread of the destruction by building a wall or sac all around the invading germs and the tissue which has been destroyed. The disease then may be said to be "arrested" and the signs of fever, loss of weight, cough, and fickle appetite will disappear. It is during this early, "active" stage of the disease that the patient has the best chances of recovery with prompt treatment.

It is in this stage, also, that nature assists the blood cells in the fight, by coughing. This effort is made to force the germs and destroyed tissue out of the bronchial tubes and air passages into the outside world. One bit of such material coughed up may contain millions of living seed of

the disease. If these are not destroyed, they may grow in some one else's body.

If every consumptive would now begin to destroy the seed of his disease as soon as they come from the body, tuberculosis would disappear from the world as soon as all who now have it recover or die.

A consumptive person, who is ignorant or careless, may infect all of his family and many other people. His lungs may be said to be a "store-house" of living seed, and his nose and mouth usually contain the germs of tuberculosis.

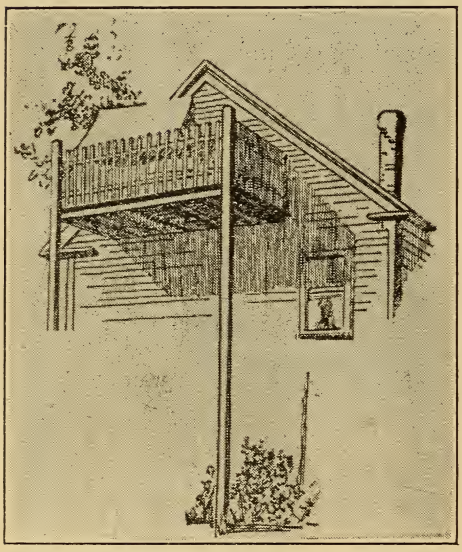


Fig. 95.—A simple and inexpensive sleeping porch.

In talking or sneezing or coughing, the droplets of saliva may carry these seed into the mouth or nose of some one near. The "sputum" or matter coughed from the lungs, if "spit" or **expectorated** on the floor, or side walk or about public places, is dangerous for many reasons.

Such sputum may become half-dried and the dust from sweeping the floor will float living germs through the air passages into the air sacs of the lungs, or the tonsils may fail to filter them out, and the germs may find their way

through the lymphatics into the lungs, or bones or other tissues of the body.

When tuberculosis attacks the lymphatic glands in the neck they become large and often "run" or discharge "matter" or **pus.** This condition is commonly called "scrofula."

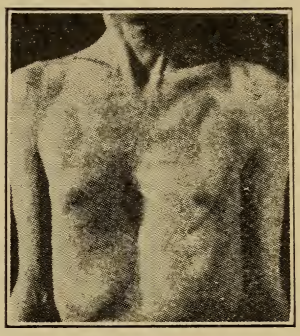


Fig. 96.—A "hollow chest" in advanced tuberculosis.

Flies readily eat sputum and often get their feet loaded with tubercle bacilli. Their next visit may be to some article of food, such as a glass of milk in which they may "take a swim." The living seed of the disease are thus washed off in the milk. Milk infected in this and other ways have been the means of infecting hundreds of thousands of people.

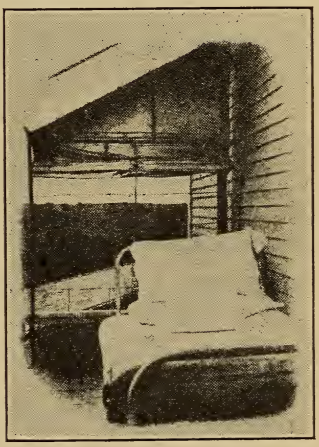


Fig. 97.—A bed in a screened porch protected from wind and rain by curtains.

Infected sputum on the side walks, floors and in public places, may be carried by rats, or on the feet into the house where in some way it reaches the food or is breathed with dust into the lungs.

The germs of tuberculosis, like most other germs that produce disease, are easily killed by strong sunlight. Thorough drying also destroys them. In half-dried sputum which may become broken up and be mixed with dust, they may live for weeks.

Bed-clothing used by a consumptive may remain dangerous for this reason for months. Such clothing should never be used after being purchased at second-hand stores or public sales until it has been boiled or "sunned" for many days.

Untidy, tuberculous waiters, cooks, clerks in food stores and laundry-women often carry infected sputum into the home where, through the food or air, the disease seed may be planted in the body.

Milk cows, on the farm, or in a dairy, many times are victims of tuberculosis in such a form that the seed of the disease escape in the milk. Babies often, after using such milk, develop tuberculosis of the bowels, which in later life, is carried by the blood or lymph to the lungs, where "consumption" develops.

Milk cows should be tested for tuberculosis and if infected, should be killed.

Summary

Tuberculosis is a world-wide disease, which attacks, probably, nearly every one sometimes during his life. Most people recover. It kills about one of every seven people of the civilized world. Its usual site of attack is the lungs.

The tubercle bacillus is its seed and, under favorable conditions, will grow in the body, or in special foods prepared in laboratories.

The leading signs of the disease are loss of weight, fever, cough and disturbances of appetite. The discovery of the germs in sputum is final proof of tuberculosis.

It is not inherited but "runs in families" because the germs are present and "sown" among other members of the family.

The germs are spread by the unguarded coughing, sneezing, talking or spitting of one who has the disease in an active stage.

They may be inhaled or swallowed with dust, food or drink.

Questions

1. What are two other names for tuberculosis?

2. How many people of the civilized world of every hundred are presumed to have had it, some time in their lives? How many of such people die of it? About what per cent., therefore, recover or die of some other cause?

3. What tissues may tuberculosis affect? Where is its usual location? What grows tuberculosis? When was this fact discovered? How did Dr. Koch prove this fact?

4. What are the conditions necessary for the growth of the germ of consumption? Why do they ever grow in the human body?

5. What would happen if the germ of tuberculosis should grow in the body, undisturbed, every time they should enter it? What prevents their growth, most of the time, in the body?

6. Name four symptoms or "danger signs" of tuberculosis.

7. What is meant by a "fickle" appetite?

8. What is meant by a "hectic flush"?

9. What is the final proof of existence of tuberculosis in the body?

10. What is a "physical examination"? When and by whom should it be made?

11. If you should ask a physician to examine you for tuberculosis and he should ask a few questions, feel your

pulse, look at the tongue and give you some medicine, would you consider him a competent doctor? Why?

12. Name four conditions which may be shown by a physical examination?

13. Is consumption "inherited"? Explain why several people in the same family, often, have tuberculosis?

14. Why may the lungs be a good growing place for the seed of tuberculosis? What is the greatest enemy to the growth of germs in the lungs?

15. After a lung is infected, explain how it may get well? When is a part of the lungs said to be "broken down" or destroyed?

16. If tuberculosis has destroyed a part of the lung as large as an apple, may the patient get well? Explain how this happens? How may it be known that the disease has been arrested?

17. When is tuberculosis most easily cured?

18. Why does a person, who has this disease, cough?

19. How do tubercle bacilli escape from the body in tuberculosis of the lungs?

20. How and when might tuberculosis disappear from the earth? (See paragraph in black type).

21. How may a consumptive infect his friends and family? What is **sputum?** What is **expectorated** sputum? When is it dangerous? How may it be inhaled into the lungs?

22. Show how flies may spread consumption?

23. What is "scrofula"?

24. How may infected sputum of the sidewalks or on the floors be mixed with our food?

25. What is the effect of sunlight and drying on these germs?

26. When may used bed-clothing be dangerous? Why? How should it be treated before being used?

27. How may milk sometimes carry tubercle bacilli into the body? What part of the body is often thus first infected?

CHAPTER XXVIII

TUBERCULOSIS (Continued)

Prevention of Tuberculosis. The best preventive of this and most other diseases is to keep the body healthy and strong by proper exercise, good food eaten at regular hours, plenty of fresh air, day and night, sufficient work to keep one busy, regular hours for sleep and rest and avoidance of vicious habits, including the use of tobacco and alcohol.

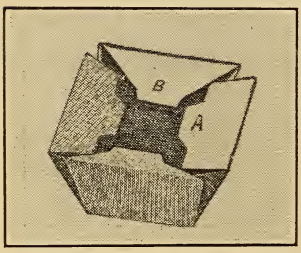


Fig. 98.—A paper lining which can be lifted from the cup and burned.

One may live, with safety, in the same house with a consumptive, if certain precautions are being taken by the victim and the nurses.

Care should be used to collect and destroy sputum. This can be done by spitting it into **sputum cups.** These are usually made of tin with a spring top, with removable paper linings. The inside may be lifted out and burned.

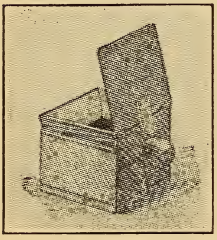


Fig. 99.—A tin sputum cup with a spring top.

When the patient coughs or sneezes, the mouth and nose should be covered with a soft cloth which may be carried in paper-lined pockets or kept moist with a five per cent. carbolic acid solution.

The hands should be frequently washed. Eating and drinking utensils after being used by the patient, should be at once boiled.

The patient should sleep alone in a well-ventilated, screened room or in a screened sleeping porch. No rugs or carpets should be on the floors, and the bed clothing

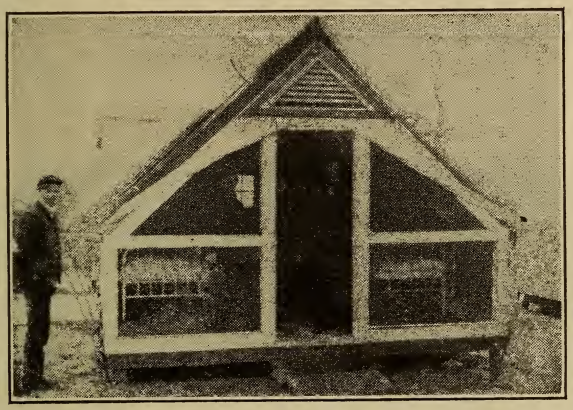


Fig. 100.—An ordinary tent with a wooden floor for out-door treatment.

must not be used by others unless it has been thoroughly boiled or sterilized.

Floors should not be swept with a dry broom, but should be rubbed with an oiled or wet mop.

The hands of the attendant should be washed before each meal.

The patient should not swallow sputum, because its germs may grow in the bowels; the mouth and teeth should be washed often to avoid this danger.

The patient should spend a few months in a tuberculosis sanatorium until recovery results, or until one may learn to live in safety with his family and friends.

Treatment of Tuberculosis. Rest, sunlight, fresh air, good food, and a good doctor are the five needs for curing tuberculosis.

Rest in bed should be the rule as long as there is fever. Exercise is often hurtful and should not be done only when ordered by the physician.

Milk, meat and eggs are three good foods and their quantity should be regulated by the doctor.

Consumptives should cough only as often as is needed to empty the air passages of mucous. Hard efforts in

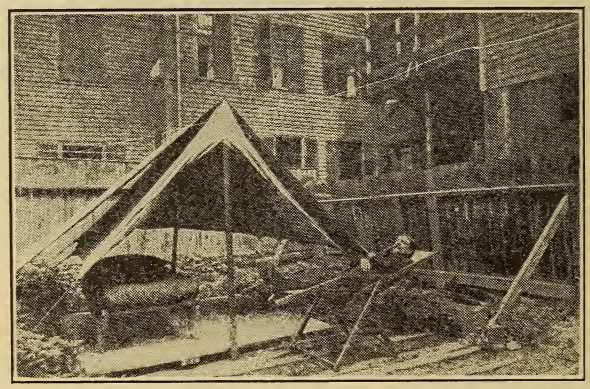


Fig. 101—Out-door treatment of tuberculosis.

coughing may burst a blood vessel in the lungs, causing a "hemorrhage" of the lungs, and may cause the infection in the lung to spread.

Consumptives should sleep in the open air, winter and summer. Protection from drafts of cold wind may be had by the use of awnings or sheets; the body may be kept warm in very cold weather by woolen blankets, woolen helmets and hot water jugs.

Window tents may be used instead of sleeping in sleeping porches. These are usually made of canvas and are so arranged that a patient may remain in his warm room and have his head at an open window through which he

may get plenty of fresh air and be protected from rain, snow, and drafts.

A woolen helmet in cold weather protects the head and ears.

Medicines are of little value in curing tuberculosis and should only be given by the doctor.

Patent medicines are usually harmful because they may contain alcohol or other habit-producing drugs and

Fig. 102.—An out-door school for children who are in danger of developing tuberculosis.

cause a patient to rely on drugs rather than the out-door rest treatment.

Summary

A healthy body is the best protection against tuberculosis and most of the other diseases.

With certain precautions observed by the victim of

tuberculosis and the attendants, one may live in safety in the same house with a consumptive.

The prompt collection and destruction of sputum is a simple rule for the prevention of the spread of the disease.

A course of treatment in a tuberculosis sanatorium will teach a person how to live with safety to others at home.

The treatment of tuberculosis should be in the hands of a competent doctor and consists of rest, food, sunshine, and fresh air. Medicines are of little value and "patent medicines" are often harmful.

Questions

1. What is the best preventive for tuberculosis?
2. What are the six general rules of health for keeping the body well and strong?
3. May a person live in safety in the same house with a consumptive? Under what conditions?
4. What should be done with the sputum? How is it done?
5. What precaution should be taken when coughing or sneezing?
6. Why should the hands of the patient and the attendants be frequently washed?
7. Why should the patient sleep alone? Where? Why use screening? What is the danger in the bed clothing of the patient if used by others, without it is sterilized?
8. How should the floors of such a bedroom be cleaned?
9. Why should not a consumptive swallow his own sputum? Why should his teeth and mouth be washed frequently?

10. What are the advantages of a period of treatment in a tuberculosis sanatorium?

11. What five great means are there for the cure of tuberculosis?

12. What is the value of rest in the treatment?

13. Why may exercise be harmful during the fever stage?

14. Name three good foods for consumptives. How should they be given?

15. What bad effects may there be from coughing too much or too hard?

16. Where should consumptives sleep? How may they be protected in cold weather?

17. What is the use of window tents? How are they used?

18. What is the value of medicine in the treatment of this disease? Why may "patent medicines" be harmful?

CHAPTER XXIX

THE EXCRETORY SYSTEM

We have learned in preceding chapters that the body is a great "workshop" or laboratory, where foods, air, and water are prepared and used to make heat, energy, and flesh, blood, and bones.

The work of the body is done by the systems of the body working in harmony and helping each other.

When work is done in any factory, kitchen, shop, or laboratory, there is always a lot of waste material or "scrap" made which must be cleared out of the way in order that work may not be delayed or impaired.

The human machine is the most wonderful and complex workshop in the world. It performs thousands of duties every hour and its operations involve most delicate and scientific work.

There are poisonous gases made, which must be thrown out of the body. Much of the food we eat is of no value and it must be cleared out of the way. Broken-down body cells would clog the machinery, if they were not removed. Sickness produces many poisons in the body.

The work of ridding the body of its wastes is done by the **excretory system** and much of it is done by organs which assist in the work of other systems.

The Organs of the Excretory System. Body wastes are removed mainly by the action of the **kidneys** and **bowels,** and they are aided by the action of the **lungs** and **skin.**

The Kidneys. The kidneys are located deep in the back just in front of the spinal column. They are two in number, dark red in color, and shaped like a dried

bean. They are usually surrounded by fat and weigh about four ounces each. They are plentifully supplied with blood and as it circulates through them, the poison, collected from body cells, is filtered out.

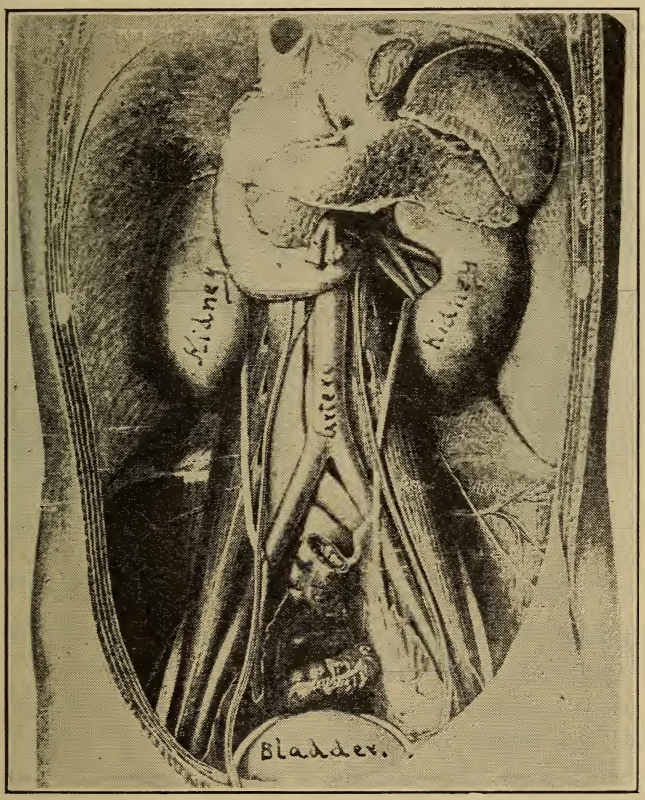


Fig. 103.—Showing relations of kidneys, blood vessels and bladder.

The chief poisons **excreted** or thrown out by the kidneys are those from proteids from the body cells or imperfectly assimilated foods.

The blood, at the same time, of course, is circulating through the lungs and carbon dioxide, from the oxidation (burning) of food in the tissue cells, is thrown out of the body in the expiration of air from the lungs.

The wastes from the kidneys, which are dissolved in water trickle through two small tubes, to a reservoir—the bladder—in the lower part of the abdomen.

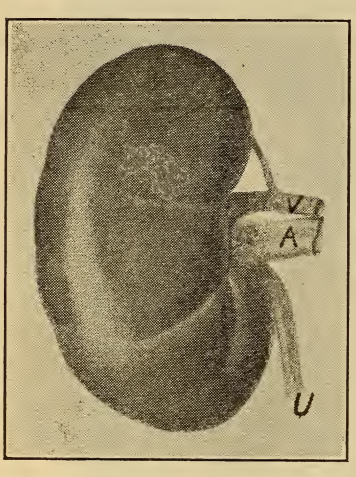


Fig. 104.—The right kidney.

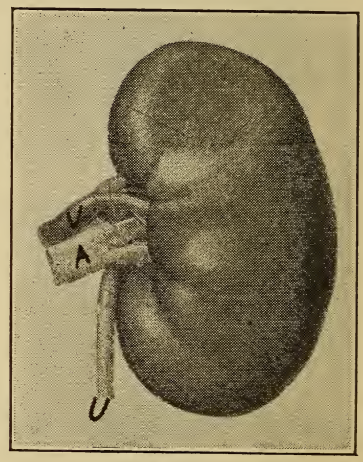


Fig. 105.—The left kidney.

A. Artery. V. Vein. U. Tube leading to the bladder.

Hygiene. Water is the fluid which nature uses so freely in performing all of her operations in the body.

Food is reduced to a fluid with it; the blood flows like water; the **sweat** or **perspiration** is mostly water; the kidneys remove body wastes in water; the bowels require much water to throw off refuse matter; the lungs throw out water with each breath and more than three-fourths of the total weight of the body is water.

It is quite evident that water should be drunk freely, if poisons are to be thrown off and the work of the body is not to be hindered.

Water should be drunk freely throughout the day. A glass or two after rising and washing the teeth, should be drunk before breakfast; three or four glasses during the morning, and as many more during the afternoon should be drunk, and, at least, two before retiring.

A half-gallon of water a day is the least amount an adult living a sedentary life should use. Persons doing hard labor frequently drink a gallon or more a day, much of it escaping from the body as "sweat."

Too much water should not be used with the meals, but a glass or two is not believed to do any harm, and it is now believed by many authorities that it aids nature in preparing the food for absorption.

Alcohol is, especially, harmful to the kidneys because its habitual use impairs the work and structure of body cells, and more poisons are thrown into the blood for the kidneys to remove. This overworks the kidney cells and they often "break down" and escape with the body wastes.

Bright's Disease is common, after continued use of alcohol, and the working cells of the kidneys are slowly destroyed until the accumulation of body wastes, which cannot be removed, poisons the victim. Alcohol often causes a growth of fat inside the kidneys and their work is impaired and the body suffers.

The Bowels. Every modern city or factory provides a way to rid itself of waste matter. The fluid wastes of a city are usually carried away by a **sewerage system** which consists of a large outlet pipe into which run the hundreds of smaller pipes from homes, factories, and office buildings.

Were this provision not made, the city would be filled with foul odors and decaying matter, which would soon cause diseases and ill health.

The bowels are the great sewer of the body, which assist it in removing its body wastes.

It is important that plenty of water be used to assist nature to clear away the waste materials from the body.

Regular habits should be practiced for, if body wastes are not promptly removed, the poisons from the bowels are absorbed into the blood and body cells are impaired. Headaches may occur, and anemia and general ill health may result.

Fruits, as apples, figs, and prunes, aid the bowels to remove wastes from the body, and may be eaten with the meal or at bedtime.

Such body wastes, during the course of typhoid fever, dysentery, "summer complaint" of children, cholera, and hookworm disease contain the seed of these diseases, and if they are not properly handled and destroyed, these seed may become scattered and grow in another person, causing a like disease.

Medicines used instead of regular habits and use of fruits, food, plenty of water are to be avoided, as the habit of taking laxatives and purgatives is soon formed, hard to break, and harmful.

Summary

The excretory system removes waste materials from the body, through the action of the kidneys and bowels, aided by the lungs and skin.

The kidneys filter the poisons of the body cells (mainly) from the blood. Plenty of water should be drunk to help them do their work.

Alcohol is destructive to kidney cells, when it is used excessively or continuously, and often causes Bright's disease.

The bowels assist nature in removing wastes from the body. During certain diseases these wastes, if not properly disposed of, are dangerous for they contain the seed of such diseases as typhoid fever, dysentery, cholera, hookworm disease, and "summer complaint" of children. If these seed escape and find their way into another person, a like disease may be produced.

Questions

1. Explain why the body may be likened unto a "workshop." What are "manufactured" in the body? Name four kinds of "wastes" which must be removed from the body.
2. Why is an excretory system necessary?
3. Name the two chief and two assistant organs of the excretory system.
4. Describe the kidneys. What is their number, color, and shape?
5. How do they remove poisons from the body cells?
6. What rids the blood of carbon dioxide? How?
7. Explain the uses of water in the body.
8. When and how much water should be drunk daily?
9. What is the effect of the continued use of alcohol on the kidneys?
10. What is the effect of "Bright's disease"?
11. What is the function of a city sewerage system? Why is one necessary?
12. What organ acts as a sewer to discharge certain body wastes?
13. What bad effects on the body often result if such body wastes are not regularly removed?
14. Name four things that may be used to assist nature to remove the wastes from the body.

CHAPTER XXX

THE BODY WASTES IN DISEASE

Typhoid Fever is a common and dangerous disease. It runs a course of four to eight weeks and leaves a victim pale, greatly reduced in weight, weak and thin. During an attack, the fever is high, the appetite poor, and often the patient is unconscious or delirious or "out of his head." About one in ten people who have the disease die, and most of the "cases" occur in young adult life.

It is a germ disease, and it can only occur in a person who in some way has swallowed the seed of the disease. It is not air-borne or carried to the body in any other way.

Fig. 106.—Ulcers in the small bowel caused by the growth of the germs of typhoid fever.

The germs after being swallowed attack the body through the mucous membrane of the small bowel, producing open sores or ulcers. Their growth there causes a poison which is absorved into the blood and produces the **fever.**

The germs of the disease escape by the millions with the body wastes from the bowels and kidneys.

It used to be common for typhoid fever to "go through" the entire family or neighborhood. Since the cause of its spread is known, a second case should not occur from the first one, when the disease appears.

If the body wastes from every person who now has typhoid fever germs in the bowels could be properly handled and at once destroyed, there would never be another case of typhoid fever in the world.

How the Disease is Spread. The poisonous body wastes of a victim of typhoid fever are carelessly handled, and in many ways they may be carried into the stomach.

The common house fly is a filthy and dangerous animal because it has so often carried the seed of typhoid fever on its body to food. It has been well named the "typhoid fly."

Fig. 107.—The germs of typhoid fever. They have the power of movement in fluids.

The body wastes may be ignorantly thrown on the ground, where they may wash or drain into wells, springs, cisterns, creeks and rivers. Such water, if used for drinking purposes, may carry into the bowels the living seed of the disease, and produce another case of typhoid. Numbers of cities have had "explosive outbreaks" of typhoid fever because the infected water supply caused many cases of the sickness at or near the same time.

The nurse or attendant may prepare food for the family without first thoroughly washing the hands and infected material may be swallowed with the food.

Rats, mice, and dogs may soil their feet and carry infectious matter from foul places into the home, where in some way it reaches the food.

A dairyman or his milkers may have typhoid fever in

the family and neglect to follow the rules for obtaining a clean milk supply and infectious material find its way into the milk. A great many cases of typhoid fever in cities have been found only in the customers of one dairy.

Unsewered cities, as a rule, have a much higher sick and death rate from typhoid fever because there are more chances for infected body wastes to pollute the water or food.

Fig. 108.—The "typhoid fly."

The Prevention of Typhoid Fever. Until every city, office, or public building and home are provided with a safe method of disposing of body wastes, every person is in danger of becoming infected with typhoid fever.

The only safe method now known to prevent this disease is by being "**immunized**" against it. A typhoid "vaccination," in nearly every instance, prevents the disease for three or four years, when it may be repeated. (See page 153.)

Fig. 109.—The eggs of the house fly.

Body wastes from a typhoid fever victim should be at once placed in a solusion of fresh chloride of lime and allowed to remain three hours. Four ounces to a gallon of water make a solution strong enough to kill the germs. The hands of the attendant should be frequently washed.

The sick room should be screened from flies, and every fly in the room killed.

The changed bed-clothing should be soaked in a solution of chloride of lime before being removed from the room.

No infected matter should be thrown upon the ground;

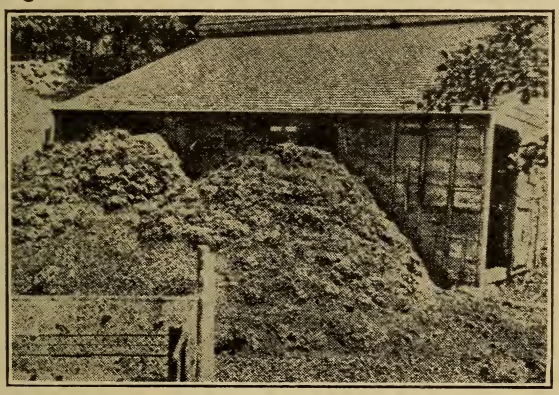


Fig. 110.—Ninety per cent of house-flies are born in stable refuse.

this includes water used for the bath of the patient. The sewer or a ditch dug away from the water supply may be used. If such material is thrown into a ditch it should be covered at once with fresh lime and earth.

Fig. 111. — The house fly seen from above.

If the drinking water is under suspicion of being infected, it should be examined in a laboratory, and in the meantime all the drinking water, and that used for washing food eaten raw, should be boiled before using.

If typhoid appears in a home or community, every person should be vaccinated for typhoid at once.

Summary

Typhoid fever is a germ disease, and, therefore, a preventable disease, and is caused by the growth of the germ in the bowels.

Its seed escape with the body wastes, and it can be prevented by properly disposing of such wastes.

Flies, fingers, and food (including water) are the three principal means by which the disease is spread.

Dairy milk may be infected with typhoid fever germs, if the disease is present in the family of the dairyman or his helpers and rules for supplying clean milk are not followed.

Vaccination is the best method now known to prevent typhoid fever. Universal use of proper means of disposing of body wastes will abolish the disease.

Care used in handling a typhoid fever patient will prevent the spread of disease.

Drinking water, pending a laboratory report, should be boiled before used for drinking or washing foods eaten raw, as lettuce, tomatoes, apples, and berries.

Questions

1. What is the duration of an attack of typhoid fever? What effect does it have on its victim? What is the average death rate of those who are ill of it?

2. What is the cause of typhoid fever? How only can typhoid fever develop in a person? Can it be "breathed" into the body? Can it be "caught" through the skin?

3. Where do typhoid fever germs grow? What causes the fever?

4. What organs rid the body of the seed of typhoid fever?

5. How might typhoid fever disappear from the world? (See black type.)

6. Why is the "typhoid fly" a dangerous animal?

7. How may the body wastes of a typhoid fever patient pollute drinking water? Should such water be used? Why?

8. What is meant by "explosive outbreaks" of typhoid fever in cities? What is the cause of such an outbreak?

9. What animals may infect food supply?

10. How may typhoid fever in the family or helpers of a dairyman be carried to other people? Why?

11. Why should cities be sewered?

12. What is a simple and harmless method of preventing typhoid fever? How long will this immunity last? Give six rules for preventing typhoid fever from "spreading" when it occurs in the home.

CHAPTER XXXI

BODY WASTES (Continued)

Hookworm Disease. In the warmer parts of the United States and in nearly all similar and torrid zones of the earth, hookworm disease is found.

It does not often make one sick enough "to go to bed." It occurs most frequently in children who, unless treated, may carry the infection for many years.

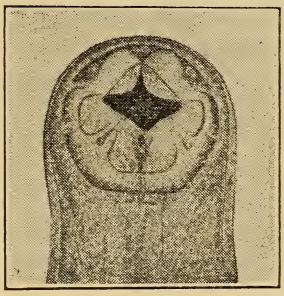


Fig. 112.—The mouth showing the "hooks" of a full grown hookworm.

Victims of the disease are usually pale, undersized and weak. Their vitality is low and their usefulness, therefore, is impaired. The disease when generally present, causes a great loss in money and efficiency to the community and the state.

Cause of Hookworm Disease. The disease is caused by the presence in the bowel of a tiny worm about an inch long and as thin as a thread. It is white in color and lives on the blood which it sucks from the tiny blood vessels of the mucous membrane of the bowel.

Its head is furnished with tiny "hooks" with which it "holds on" and sucks the blood. One worm is said to use about a drop of blood every day. The body wastes of the hookworm are squirted into the blood of the victim which poison the blood and tissue cells. The loss of blood and the absorption of these wastes are the cause of the undersize and anemia of the victims when a large number of worms are present in the bowel.

These worms do not multiply in the bowel, but like most other worms they lay their eggs; the female, at times, laying as many as three hundred in a day, each of which is so small it can not be seen with the naked eye. These eggs escape from the bowel with other body wastes.

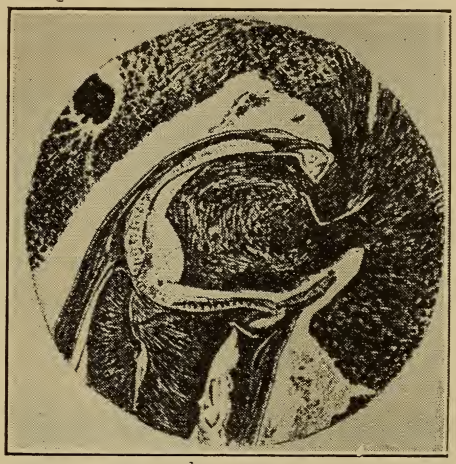


Fig. 113.—Showing the hookworm feeding and attached to the wall of the bowel.

If this material is carelessly disposed of and it reaches soft, moist, warm soil, the eggs soon "hatch out" and in a few days they are in the **infective** stage.

How the Worms Get Into the Bowel. These tiny worms, only a few days old, live in moist soil. If such soil is "worked" by the bare hands, or is walked upon by bare feet, these worms pierce the skin and get into the blood stream. They float through the blood vessels and when they reach the lungs, they break through the delicate lining of the air sacs into the bronchial tubes. When one coughs, these worms are "coughed up" and often swallowed, where they quickly reach their future home in the bowel and grow to their full size.

Fig. 114.—The newly hatched hookworm (greatly magnified.)

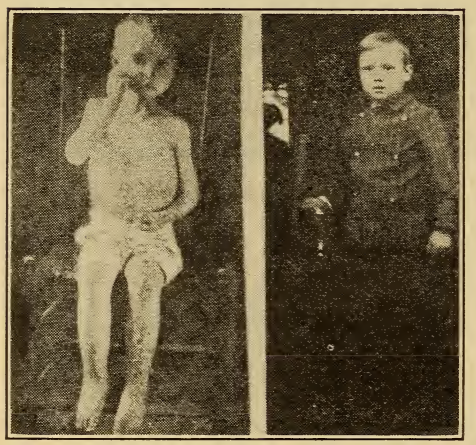
When these worms first enter the skin, they make a kind of "sore" called "dew-itch" or "toe-itch" or "dew-poison." The skin just under the bend of the toes is thin and this is the most frequent point of entrance.

A B

Fig. 115.—Eggs of the hookworm. A. Beginning development. B. Ready to "hatch." (Magnified.)

The Cure of Hookworm Disease is very simple. The first step is to prove that the worms are present in the bowel. This is easily done with the aid of a microscope in a laboratory for the tiny eggs may be seen in such body wastes.

The second step is to take a few doses of medicine under the care of a physician. This will make the worms loosen their hold and they are made to escape with the body wastes.



A B

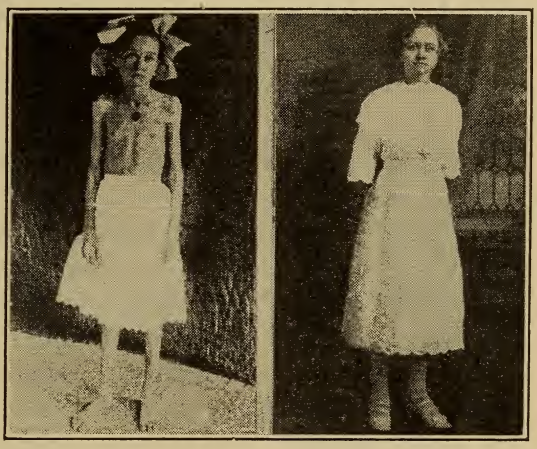
Fig. 116.—A. Showing the boy before treatment for hookworm disease. B. The same boy a few months later.

Hookworm disease untreated may last for years. Properly treated, it can be relieved, usually, in a few days..

Benefits of Treatment. The changes for good after such treatment are often truly wonderful. Children take on rapid flesh and growth; their minds and bodies become active; their color becomes ruddy and good health is enjoyed.

Adults who, many times, were leading useless, workless lives are given new life and often become self-supporting and **useful citizens.**

Prevention of Hookworm Disease. Proper disposal of the body's wastes will prevent hookworm disease and also typhoid fever and like diseases.



A B

Fig. 117.—A. Showing the girl with hookworm disease. B. The same girl a few months after treatment.

Unfortunately a great many homes, school houses, hotels and other public places have no proper place or method of disposing of body wastes. A water-tight and fly-tight vault should be constructed at every such place and their use and care enforced by law.

Summary

Hookworm disease is prevalent in warm countries, long-continued in its effect, preventable and easily curable.

It is caused by a parasite living in the bowels, which sucks blood and injects its own poison into the blood of its victim.

Its eggs, under favorable conditions hatch and the tiny

worms find their way through the skin of a victim into the blood stream, and through the air passages into the mouth where they are swallowed and carried into the bowels.

The cure of hookworm disease consists in the removal by drugs of the worms from the bowel.

Hookworm disease can be prevented by the proper disposal of the body wastes, by the use of sanitary closets.

Questions

1. Where is hookworm disease most often found? How long may an attack last?
2. Name five symptoms of hookworm disease.
3. What is the cause of the disease? Describe a hookworm? What is its food? How much food does it require? How does it poison the body cells?
4. What causes the anemia and reduced size of children who have severe hookworm disease?
5. How do hookworms reproduce themselves? Where do they "hatch" best?
6. How do young hookworms get into the skin? Into the lungs? Into the mouth? Into the bowels?
7. What is "toe-itch"? Dew-poison? Dew-itch? If a bit of such skin were shaved off and put under a misroscope, what would you expect to see?
8. How is hookworm disease cured?
9. What effect will the proper disposal by everybody of the body wastes have on hookworm disease?

CHAPTER XXXII

THE SKIN

The skin is the smooth, tough, and pliable covering for the entire body. At the ends of the fingers and toes it is changed in its structure to form the **nails.** Hair is a similar modification of skin.

At the entrances into the body the skin changes its structure and joins a more delicate and thinner lining, the **mucous membrane.**

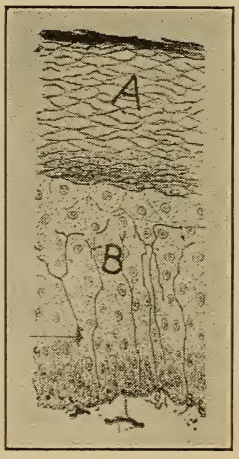


Fig. 118.—Stucture of skin. A. Epidermis. B. Dermis. (Greatly magnified.)

Functions of the Skin. Aside from its use in giving a finish and beauty to the body, it has four distinct functions. First, it forms a protective coating for the delicate blood vessels, glands and nerves; second, it is the seat of feeling by which we are made aware of pain, heat, weight, and cold; third, it aids in regulating the heat of the body, and, fourth, it aids the lungs, bowels, and kidneys in removing wastes from the body.

Structure of the skin. The skin is composed of two layers; the outer, horny layer, the **epidermis** and the inner, delicate one, the **dermis** or true skin. The epidermis has no sensitive nerves or blood vessels and is thick enough to protect the delicate layer beneath. Who has not burned a blister on the hand? The elevated layer which fills with "water" (serum) is the epidermis. A needle may be

pushed through this layer without pain, but if the delicate dermis below is touched, pain is at once felt.

"Corns" are thickened spots of epidermis and are caused by rubbing or friction. Shoes that are too loose, ill-fitting, or too tight often produce corns. The "horny" hands of a working man are made so by constant friction of tools in the hands.

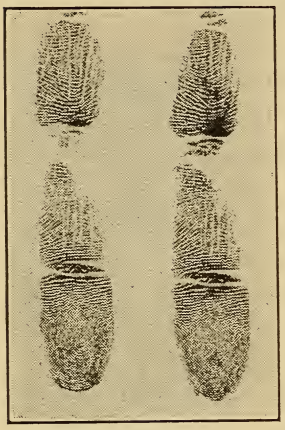


Fig. 119.—Finger prints of the epidermis. They are used to identify persons and are more constant and reliable than photographs of the face.

The epidermis is constantly being worn away, and is as rapidly restored, by the growth of cells in the dermis.

Complexions of the skin are due to the amount of coloring matter found in the epidermis. The color of different races of people is determined by the kind and amount of this coloring matter. The negro is dark or black for this reason.

The **dermis** is plentifully supplied with nerves and blood vessels which end in tiny projections called **papillae.**

The epidermis fits and is closely moulded upon these ridges. The nerve **papillae** are most numerous over the parts of the body with which one feels, as in the ends of the fingers, on the cheek, lips, and tip of the tongue.

The lower layer of the skin is made up mostly of fat and connective tissue. These two tissues make the skin tough, soft, and elastic or pliable, and form the bed for the hairs, **sebaceous** and **sweat glands.**

Hairs are placed on the body for its protection. They are not found in the palms of the hands or soles of the feet. The hair of the head adds beauty to the body and protects the head against heavy blows. The hair of the nose and eyes help to protect the delicate membranes from dust and foreign bodies.

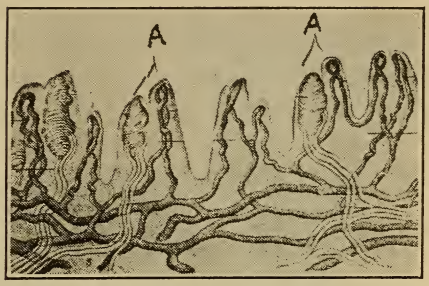


Fig. 120.—Showing A. Papillae with blood vessels and nerve endings.

The sebaceous glands in the deeper layer of the skin **secrete** and pour out an odorless oil which keeps the skin smooth and pliable. This is the oil which makes the hair smooth and glossy.

The **Sweat Glands** are located in the deeper layer of the skin. Their mouths may be seen in the palm of the hands with a magnifying glass of low power. The blood capillaries carry certain body wastes to these millions of tiny glands over the entire body and they pour out a fluid, the **sweat** or **perspiration**, which contains waste materials from the cells. By this action, the heat of the body is regulated.

Heat Regulation of the Body. During heavy exercising, as in running, boxing, hoeing, or plowing, more heat is produced in the blood by reason of the rapid oxidation in the body cells. Nature, at once, sends the blood to the skin to be cooled by contact with the air. The sweat glands help by pouring out over the surface of the body a "sweat." This **evaporates** quickly into the air and the blood is

cooled, very much like air about a house may be cooled by sprinkling the grounds with water.

During cold weather, the blood may become chilled and it becomes necessary to save heat. The **nervous** system sends out a message to the tiny blood vessels under the skin to contract and the blood is forced away from the

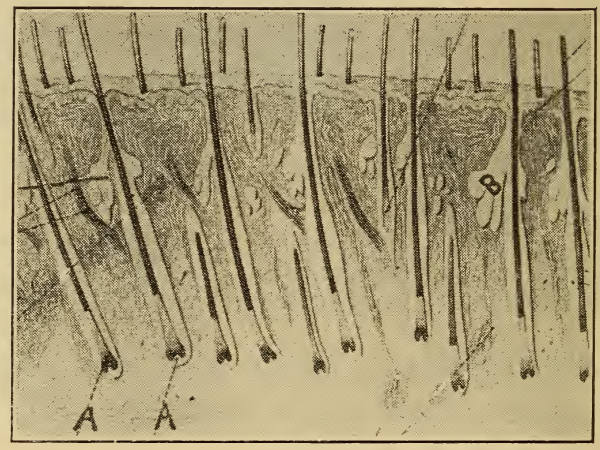


Fig. 121.—Section of skin showing (A) hairs. (B) Sebaceous glands.

surface of the body into the deeper tissues where it may retain its heat. Thus it is, that in hot or cold weather, during a period of rest or exercise, the body heat is kept at one even temperature. In health the body temperature is maintained at 98 3/5° F.

Sickness and Body Temperature. During illness often the temperature of the body reaches 103 or 104°. Oxidation is rapid and the skin fails in its task of maintaining an even temperature. The person is then said to have a **fever.**

Fever is present in all of the **acute infectious** diseases caused by bacteria. A heavy infection of one kind of malaria will cause a **chill** followed by a fever. The poison thrown off by the malaria causes a rapid oxidation of tissue cells and the blood is sent to the skin to be cooled. The sweat glands pour a copious perspiration over the body and fever soon disappears by the cooling of the body. The "sweating" in the kind of malaria which produces the "chill and fever" is caused for this reason.

Fig. 122.—A well kept nail.

The nails add beauty to the hands and feet. They are useful to protect the delicate tips of the fingers and assist in picking up small objects. They grow from the layers of skin of their under-surface and at their roots, (**matrix**). Care should be used to keep dirt from accumulating under the nails and around their edges.

Dirty nails are unsightly and may carry infectious matter into the body.

The nails of the toes of the so-called civilized people are often deformed by the use of ill-fitting shoes.

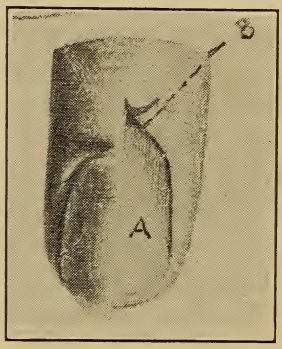


Fig. 123.—A finger nail showing the matrix. A. Seat of growth of the nail in thickness. B. In length.

Summary

The uses of the skin are for protection, for excreting wastes, regulating the body heat, and to provide a means for feeling.

The epidermis is of varying thickness and is without blood vessels, nerves, fat, connective tissue, sebaceous and sweat glands.

Hair, nails, and mucous membranes and hoofs and horns of the lower animals are only modified forms of the skin.

The heat of the body is kept at one temperature in health, regardless of heat, cold, exercise, or rest, by the action of the skin through the control of the **nervous system.**

Questions

1. What kind of tissue is the skin? Where is it found? What relation has it to hair, nails and mucous membranes?
2. Name four functions of the skin.
3. What is the epidermis? What are its functions? What are corns? Where may they be found? How may a soldier have corns on his shoulders?
4. How is the epidermis renewed?
5. Why are complexions of the skin? What makes an Indian red and a Chinaman yellow?
6. What kind of tissues are found in the dermis? What are papillae? Where are they most abundant? Why?
7. What gives to the skin its **pliability** and toughness?
8. Why are hairs furnished for the body? Give three illustrations of the use of hairs.
9. What are sebaceous glands? Where are they? What is their function?
10. Where are the sweat glands? What two functions have they? How do they throw off poisons from the body?
11. Why does the blood become hotter during exercise? Where is it cooled? How is it done?
12. Why is the skin freer from blood when the body is

exposed to cold than it is on a hot day? What is the function of the tiny muscles in the skin? What controls their action.

13. What is the normal temperature of the body? When is it increased?

14. Show how a heavy infection of malaria causes fever. How is the fever reduced? What is a chill?

15. What two functions have the nails? How do they grow? Why should they be kept clean?

CHAPTER XXXIII

HYGIENE OF THE SKIN

Hygiene. The skin can do its work best when it is kept clean. The impurities of the body, excreted by sweat glands, and the worn-out cells of the outer skin, if not removed, soon give off a disagreeable odor, and form a good growing place for germs. Pimples and little "boils" over the body are often caused by an unwashed skin.

Bathing. A cleansing bath for the entire body is needed at least twice during the week to keep the body free from its impurities and the dust, soot, and dirt. Such a bath should be taken at bedtime, using warm or hot water and pure soap. The soap aids the water in dissolving and removing the oil from the skin. The hot water brings the blood to the vessels in the skin from the overworked brain or muscles, so that one becomes "sleepy." A hot bath, therefore, is a **sedative.**

Sleeplessness, worry, and fatigue often may be relieved and a good night's rest secured by taking a hot bath before retiring.

Cold Baths contract the blood vessels of the skin and drive the blood into the muscles, brain, and internal organs. It is a **stimulant** and many people form a habit of taking a cold bath every morning to arouse the brain and activities of the body. At once, after the cold plunge or "shower," the skin should be rubbed briskly with a coarse towel. This stimulates the blood vessels of the skin and the blood rushes into them, causing the "redness" or glow of such a bath.

The Face and Hands require frequent washing, because they are exposed to the dirt of the air and the hands are soiled by the work they do. Often the hands pick up dangerous bacteria and they should be washed thoroughly with soap and water before eating or preparing a meal.

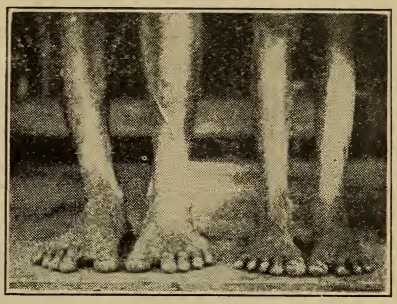


Fig. 124.—Showing big toe in a line with the side of the foot in unshod savages.

The Feet pick up dust from the street and while at work. Shoes are not dust or water-tight and the feet become unclean quickly and require frequent cleansing. Very often the feet give off a bad odor. This may not be because they are not frequently bathed, but because of an infection by certain germs which are growing in the skin and between the toes. A physician can relieve this by ordering an antiseptic for the foot-bath and a similar powder to be "dusted" into the stockings and shoes.

Fig. 125.—Showing natural direction of the big toe. (Feet of an unshod savage.)

Hot baths should not be taken at once after meals because the blood will be drawn away from the digestive organs which need it for their work. A cold bath should not be taken when one is hot or tired, because the body may become chilled too quickly. The work one does and the state of health

will be the guides for the number and kind of baths one may need.

Clothing. The skin alone, in cold climates and those subject to sudden changes in weather, can not keep the body heat at an even temperature. Clothing is needed to protect the body from injuries, insects, bacteria, and to keep the body heat regulated by preventing too much or too rapid loss of the body heat. Clothing does not "warm" anybody. It simply prevents the escape of heat from the body. In cold weather the cloth should be loosely woven so that the air spaces between the threads will prevent heat from passing through. Most of our clothing is made from the hairs of animals (woolen cloths and furs) or fibers from plants (cotton or linen) or silk which is the web of a caterpillar.

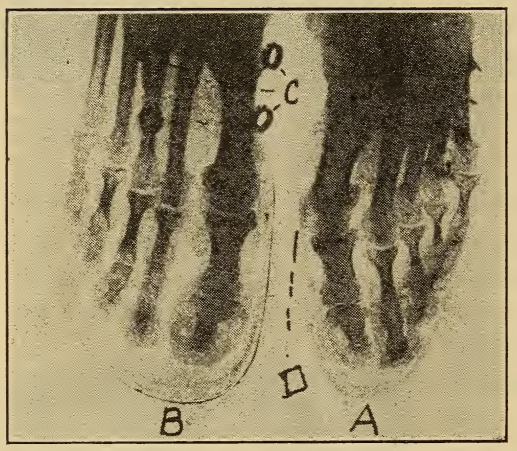


Fig. 126.—An X-ray picture of feet in shoes. A. Showing crowding of bones in a shoe too tight across the toes. B. Showing the proper arrangement of the bones in a well-fitted shoe. C. Eyelets for lacing shoe. D. Where bunions often form.

Woolen cloth is best for winter wear because heat does not pass through the many openings between its threads, or as it is sometimes said, it is a poor conductor of heat. Two layers of thin clothing are often warmer than one layer of thick clothing because of the layer of "non-con-

ducting'' air between them. Newspapers folded over the chest under the coat are often used by travelers to keep them warm. The papers make several layers of air through which the heat from the body has difficulty in escaping.

When clothing becomes wet, the air spaces are filled with water instead of air, and it then permits the body heat to escape, and the body becomes chilled. It is for this reason that the body should be at once freed from wet clothing, rubbed dry until it is all aglow and clothed with dry clothing. If this is not done the germs of colds, influenza, pneumonia, or other like diseases may take advantage of the lowered body resistance and produce disease of the air passages.

Fig. 127. — The "track" made by a flat foot.

Linen and Cotton clothes are cooler in summer because the woven cloth does not contain air spaces that will hold the body heat and it is allowed to escape quickly.

A Change of Clothing worn next to the skin should be made often enough to keep the skin free from its impurities. It should be changed after each cleansing bath, otherwise the animal matter in the body wastes will soon decompose and give off a foul odor.

Tight-Fitting clothing should not be worn over the chest or abdomen because of its interference with the breathing and the work of the digestive system. Tight shoes are often the cause of cold feet because the flow of blood through the feet is obstructed. If the legs are not warmly clad, the feet may become cold because the

blood vessels of the legs contract and a reduced amount of blood is supplied the feet.

Shoes. A great deal of unnecessary pain and discomfort are the result of ill-fitting or improperly built shoes. The high "peg top" heel of many shoes for women is a foolish device of shoe makers, for such shoes make women walk on their toes instead of their feet. Many of the men's shoes are pointed and curved out of the shape of the natural foot. As a result more than one-half of the men and women have corns on their feet and suffer from flat-feet and the pains of over-strained muscles and nerves. Many of them have painful swollen joints on their feet or "bunions." Shoes should have low, broad heels and a sole broad enough to cover the bottom of the foot, without squeezing the toes.

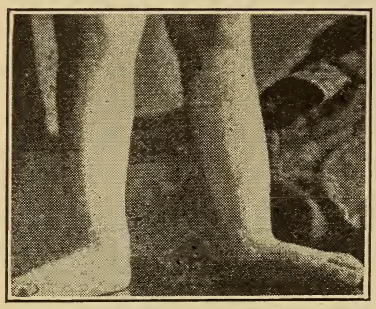


Fig. 128.—Flat-foot. Note the instep has almost disappeared.

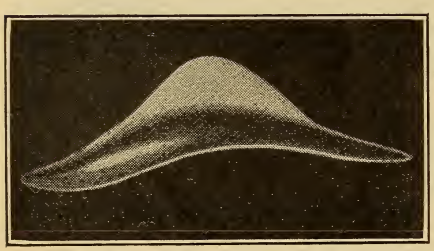


Fig. 129.—A metal arch that often will relieve the distress caused by a flat foot.

Flat Feet are often caused by wearing shoes ill-fitting and too tight. The bony arch of the foot becomes flattened and the muscles of the leg are strained in their effort to support the weight of the body while walking or standing. Many recruits of the army were discharged because their

"flat-feet" would not permit them to stand the hard training.

It is called "flat-foot" because when standing the foot lies flat all the way across on the inner side of the foot. Certain exercises, as running, playing tennis, tip-toeing may strengthen the muscles and help restore the fallen arch. A metal support worn in the shoes often gives much relief.

Summary

A skin to be healthy must be clean and cleansing baths are needed to free the body from accumulated dust, dirt, soot, and the excretions from the skin.

Hot baths are **sedatives** and cold baths are **stimulants.**

The functions of clothing, aside from their safeguarding of the sense of decency, are to protect the body from external injury and to help the skin regulate the body heat. Woolens are best for winter wear because they are "non-conductors" of heat; linen and cotton, for summer wear because they permit the escape of body heat. Wet clothing becomes a conductor of heat and when worn, may cause a disease of the air passages by the sudden lowering of the body's resisting power through loss of body heat.

Shoes should be built to fit the foot and feet should not be deformed to fit the shoes. Flat-feet, corns, pain, and an awkward gait are often the penalties paid by wearers of ill-fitting or improperly made shoes.

Questions

1. Why should the skin be kept clean? What sometimes is the cause of pimples and boils in the skin?

2. How often does the entire body need a cleansing bath? How should it be taken? What is the advantage in using soap?

3. How may sleep often be induced when one is tired? Why?

4. What is the effect of a cold bath? When should it be taken? How? When should it not be taken? Why?

5. Should a hot bath be taken just before or after a meal?

6. Why should the hands be washed before eating or preparing a meal?

7. Why should the feet be washed often? What is many times the cause of "smelling feet?" How may they be relieved?

8. What should guide one in the choice of the kind and frequency of baths?

9. What three functions does clothing preform? Do clothes "warm" the body? Why are they worn in cold weather?

10. Why is woolen clothing warmer than cotton, linen or silk, in cold weather? How may newspapers be used to keep one warm? Why?

11. Why may two thin garments be warmer than one thick one?

12. What is meant by woolens being a "poor conductor of heat?" When may the same clothing become a good conductor of heat?

13. Why should one "change clothes" when they become soaked with rain?

14. Why is cotton and linen clothing cooler in summer?

15. Why should underclothing be changed frequently?

16. Name three evil results of wearing tight clothing.

17. Why are "peg-top" high-heeled shoes harmful? What objection is often found with men's shoes? What is a great cause of corns? What is a "bunion."

18. How should shoes be built?

19. How may one know a shoe is built correctly?

20. What is "flat-foot?" What are the symptoms of flat-feet? In what two ways may relief be obtained?

CHAPTER XXXIV

THE NERVOUS SYSTEM

It has been shown in the preceding chapters how the many organs perform their tasks and how each system of the body accomplishes its purpose.

The heart pumps so often when the body is at rest and more rapidly during exercise; the lungs take in so much air and, if a need arises, at once, may commence to inhale greater quantities of air at shorter intervals. The stomach and bowels work in harmony and the glands pour out their digestive juices just at the right time for their use; the kidneys release poisons while other organs help them by doing their particular work.

Every organ and each system seem to do the right thing at the right time, and unless one is ill, there are no "strikes" of the workers of the body.

The harmony and efficiency of the thousands of operations of the human body are not the result of accident. Such team work is only possible when there is management and control.

So we have now come to the study of the **nervous system**, through which every operation of the body is directed.

Not a body sell is made, a motion produced, a particle of food assimilated, a heart throb completed, a breath of air inhaled, a sweat gland operated unless it is directed and controlled by some agent of the nervous system.

The Brain, the Spinal Cord and the Nerves are the chief organs which direct and carry out the work of the body. They make up what is called the **central nervous** system.

Did you ever think what a wonderful machine the human body really is? A man succeeded once in making an automatic doll that would walk in a clumsy way around a circle. When it was placed in a show window, great crowds of people gathered around to see it perform and wondered how it was made to "work." How much more wonderful are the performances of the living body which walks, runs in any direction, dances, sings, thinks, works and creates, and scarcely a thought is ever given to its work or the controlling power which directs it!

Decide now that you want to reach in your pocket for a pencil. What happens? A message was sent from your brain, through the arm nerves to the muscles of your arm and fingers; they contracted and carried your hand to the proper pocket; your fingers closed on the pencil. The arm muscles pulled the pencil from the pocket and the job is complete. This was done as a result of the action of the **will** and was a **voluntary** act. Suppose in reaching in the pocket the fingers have been stuck with a pin. Before your brain could **think** to tell you to take the arm away, the arm has been ordered, over the nerves of the arm muscles, to jerk away from the thing which caused you **pain.** Such an action is an **involuntary** act or a **reflex action.**

If one bites an apple, it is because a message has reached the brain that one is hungry; the brain sends a message to the hand to pick up an apple and carry it to the mouth and directs the muscles of the jaw to pinch a bite from the apple, with the teeth, and to chew it into pieces. These are **voluntary** acts controlled by the brain through **nerves** leading to the muscles. While the apple is being chewed, the tongue moves the pieces

here and there in the mouth, between the jaws, to help reduce them to a pulp, and skillfully dodges the grinders because it seems to have learned that a bite on the tongue is painful. The muscles of the cheeks in response to an order from their nerves hold the pieces of apple firmly so that the teeth may crush them; the nerves of the tongue are busy giving one the pleasant feeling of taste, and at once, the **salivary glands,** responding to a message from their nerves, pour out the saliva to help digest the fruit. The muscles of the throat are waiting for a message from their nerves, ready to seize the ground apple and carry it into the stomach.

The actions of the tongue, the cheek, the salivary glands and the throat muscles are not directed by a message from the mind or brain, but by nerve centers in the spinal cord or one of its subagents. The brain is the "general superintendent" of the whole work of control and most of the routine work of the body is left to the spinal cord, and its helpers.

How the Nervous System Works. Think of a telephone system in a city. You will recall that there are hundreds of wires, stretched from pole to pole, over every street. If each of these wires is followed, it is seen to enter a home, a hotel, a factory, or public building, and each one, finally, ends in a telephone box which is fitted so that a message may be **received** or **sent.**

If these wires are followed in the other direction they are seen to become thicker and more numerous and, finally, a great number are seen to enter into lead tubes or "cables" for convenience in carrying so many wires. If these cables are followed, they will lead into the telephone center or exchange. There a large number of girls will be found at work in front of a long desk, fac-

ing the "switch board," which presents thousands of holes, each of which represents the end of one of the wires leading to every part of the great city. Listen to what is said: "Hello, Central, give me 1-6-7.' Hundreds of such calls come in every minute. The girl picks up a "plug," which is the end of the wire, over which the request came, and at once the person who "called" can give or receive a message.

In a general way, the work of a telephone system may be likened to the work of the central nervous system. The tissue cells of the muscles, glands, lungs, arteries. liver, heart and every organ of the body may be said to represent the telephone boxes in the houses and the buildings in a city which have a telephone; the nerves are the telephone wires; the large nerves nearing the cord are the cables; and the brain and spinal cord may be likened unto the exchange. Body cells may receive and give messages or **impulses.** A body cell comes in contact with a sharp point of a needle, a message is **sent** over its nerve (the wires) to the spinal cord or one of its helpers (the exchange). A "connection" is made from the cord over the nerves (wires) and the message, "jerk away," is flashed to the muscle cells which **receive** the **impulse** and contract, and body cells are saved from further destruction.

Thousands of messages are received and sent by the brain and spinal cord every minute in response to the calls from the body cells at work.

Many thousands of the nerve impulses from the body cells are received and answered by the "helpers" or "subagents" of the cord. These are collections of nerve tissue along the course of the large nerves near the cord and are called **ganglia** (singular ganglion).

The ganglia offer a quicker and a shorter route for receiving and sending impluses. They are intimately connected with the spinal cord and brain and work in entire harmony and at their direction. The ganglia are concerned mostly with the involuntary actions of body cells, as in digestion, secretion, excretion, respiration and the circulation of blood and lymph. The ganglia and their connections are spoken of as the **sympathetic nervous system.**

Questions

1. Name six functions of the body which are performed in harmony. Is such harmony in the body's work an accident? Why is it possible?

2. What is the function of the nervous system? Name at least ten operations in the body which are controlled by it.

3. What are the principal organs of the nervous system? What is the central nervous system?

4. Tell of the part the central nervous system takes if you walk to the door and return; if you put your finger on a hot iron.

5. What is a voluntary action? An involuntary action?

6. Name the voluntary acts performed when an apple is eaten. Name four involuntary acts before it reaches the stomach.

7. Describe a telephone system in a city. What is the "exchange?" A "cable?" What are the wires? Telephone boxes? How are calls received? Sent? Illustrate.

8. How may the central nervous system be compared to a telephone system? What organs correspond to the

"telephone exchange?" To the "cables?" To the wires? To the telephone boxes?

9. If body cells come in contact with a burning match, what is the first message sent? How? Where? What receives this message? What is at once ordered? What is almost instantly done? What is the purpose of this arrangement in this case?

10. How many **nerve impulses** are sent into the brain, spinal cord and its assistants every hour? What are ten of such impulses?

11. What is meant by the "subagents?" The "helpers or assistants" of the spinal cord? What is their name? What is their function? How do they work?

12. Name five functions of the "Sympathetic Nervous System."

CHAPTER XXXV

THE ORGANS OF THE NERVOUS SYSTEM

The Brain is one of the largest organs in the body. Its average weight is about three pounds. It is oval in shape

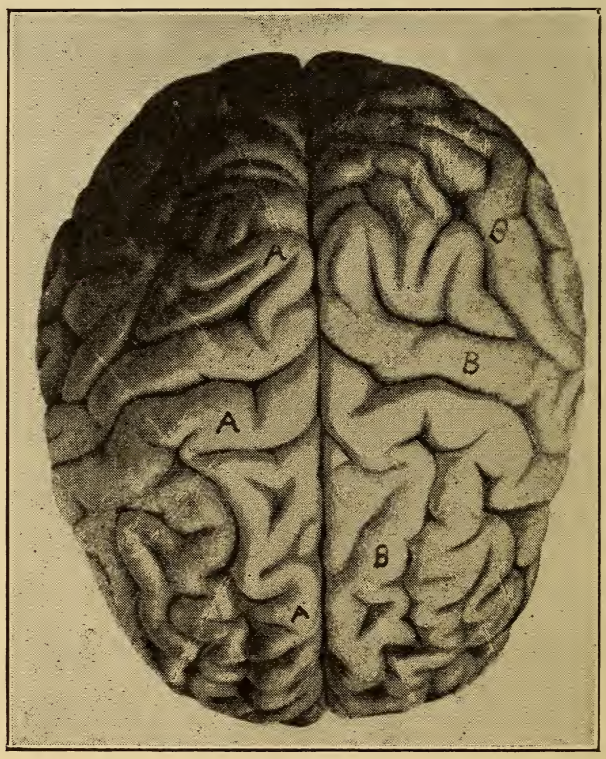


Fig. 130.—The brain as seen from above. (The cerebrum). A. Convolutions of right hemisphere. B. Convolutions of left hemisphere.

to fit the cavity formed by the bones of the skull. A deep groove running from the front across the top to the

back divides it almost in half, forming the right and left **hemispheres** of the brain.

Its surface is wrinkled or irregular and the smooth ridges are called the **convolutions** of the brain.

If it were cut across, the brain substance, of which it is composed, is found to be soft and easily torn. The outside of the brain is composed of grayish matter which includes all of the convolutions. Under the layer of **gray matter**, the larger remainder of the brain is composed of **white matter**. The largest part of the brain occupies the front and top of the skull and is known as the **cerebrum**.

The brain is made of **nerve cells** and their **fibers** or branches which, like a net work, connect the brain cells with one another. Some of these fibers enter the brain from the eyes, nose, tongue and ears and through their aid, one sees, smells, tastes and hears. At the bottom of the brain and at the rear is a smaller division of the brain, the **cerebellum**.

Fig. 131.—A nerve cell with its many branches. (Magnified.)

A great number of nerve fibers enter the cerebellum from the spinal cord. Many of these nerves are used to convey messages to the brain of voluntary movements and for unity of action or purpose.

The **cerebrum** is the part of the brain used in thinking, willing and remembering. Through it we are **conscious** of what is going on around us. A person whose cerebrum is not developed is an idiot.

Below the cerebellum, the nerve tissue passes out of the skull into the hollow tunnel of the spinal column.

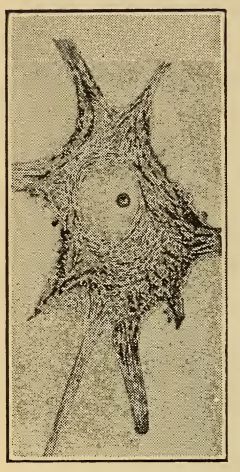


Fig. 132.—A nerve cell (greatly magnified and enlarged). Note its branches are cut off.

Just before it leaves the skull there is a portion of it smaller than the cerebellum and larger than the cord called the **medulla.** It is in the **medulla** that the nerve fibers from the cord cross to their position in the opposite side of the brain.

If the right side of the brain be injured, the left side of the body may be **paralyzed,** that is, the muscles of the arm or leg cannot receive their "orders" to act because the **nerve centers** or cells, which direct them, are prevented from operating.

A blow on the right side of the head may cause a blood clot to form over the brain cells that control the leg, causing them to quit their work. The left leg becomes powerless to move. If the blood clot is promptly removed and the **pressure** removed from such brain cells, they will again work and the useless limb will again perform its functions under the orders from the rescued brain cells.

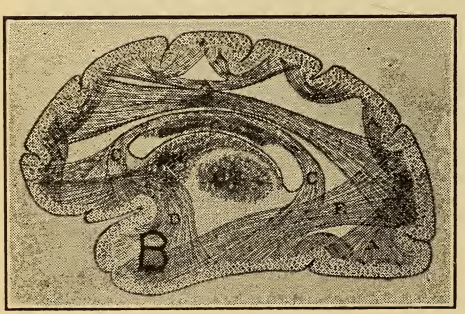


Fig. 133.—The brain cut through from end to end. B. Cerebellum. Note the connection of various parts of the brain with each other. (A, E, C, D.)

The Spinal Cord. The nerve tissue after leaving the skull passes into the hollow canal in the backbone and is now

called the **spinal cord.** In the lower animals it is called the "marrow of the backbone."

The cord is about a foot and one-half long in the adult, and as large as one's little finger. It is a bundle of nerve fibers, in the center of which is **gray matter.** The outside layer of the cord is **white** matter.

Two **fissures** or cracks run from one end of the cord to the other, dividing it into two parts which are connected in the center of the cord.

As is passes downward, the cord gives off thirty-one pairs of nerves, which are distributed to nearly every part of the body. These are called the **spinal** nerves. They pass out between the bones of the spinal column.

Each spinal nerve has two roots; one from the front of the cord (anterior root of the gray matter of the cord) and the other from the back of the cord (posterior root). The two roots soon unite to form a single nerve, but the nerve fibers remain separated as do the wires in a telephone cable and the fibers from each root do their particular duty. The fibers from the anterior root carry messages for **motion** and are known as the **motor** fibers; the fibers from the posterior root carry **sensation** and are known as **sensory** fibers.

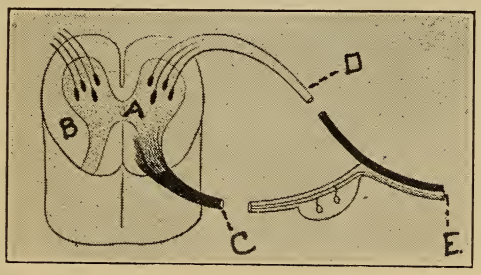


Fig. 134.—The spinal cord. A. Gray matter. B. White matter. C. Posterior root of a spinal nerve. D. Anterior root of a spinal nerve. E. A spinal nerve.

Such a nerve leading to the fingers, for example, can carry a message to the cord and to the brain of the

weight, the heat or the "feel" of an object, and the same nerve can carry the order back to the fingers for the control of their movement. Thus do we see that body cells may be likened to the "telephone boxes" in a city telephone system from which messages may be either sent or received.

Nerve Cells differ from most of the body cells because they send off tiny branches, reminding one of the branches of a tree, which may extend to a distance of an inch or more. It is by means of these tiny branches, connecting many cells together, that "teamwork" of the body's parts may be done. One of these branches of a nerve cell may extend two or three feet from the nerve cell. This extension is known as a **nerve fiber.**

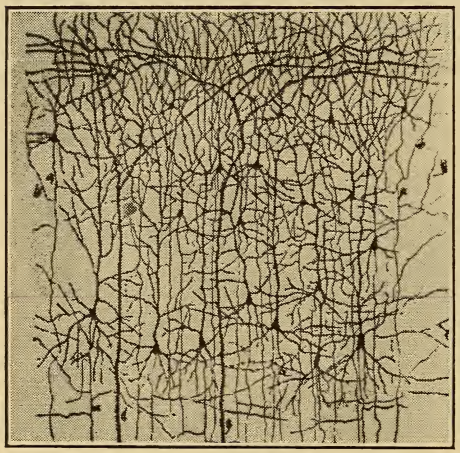


Fig. 135.—Nerve cells and their fibers, showing how they connect like network with each other.

The Nerves. A nerve is only a collection of nerve fibers or extensions from nerve cells. These fibers run side by side and are enclosed in a sheath or wrapping of connective tissue in which are tiny blood vessels to supply them with nourishment.

Most of the nerves of the body look like glistening white threads, and as they pursue their course to supply every organ and group of nerve cells they divide and send off branches very much like the arteries until

their ends become so small they cannot be seen with the eye alone.

Nerves receive fibers from many other nerves as they leave the spinal cord.

Plexus of Nerves. As the spinal nerves leave the cord, many times they form a network in which nerve fibers from one group of nerves are merged with fibers of another nerve. Such a collection and distribution of nerve fibers is called a **plexus**. It is by such means that team work of the systems and their organs is accomplished.

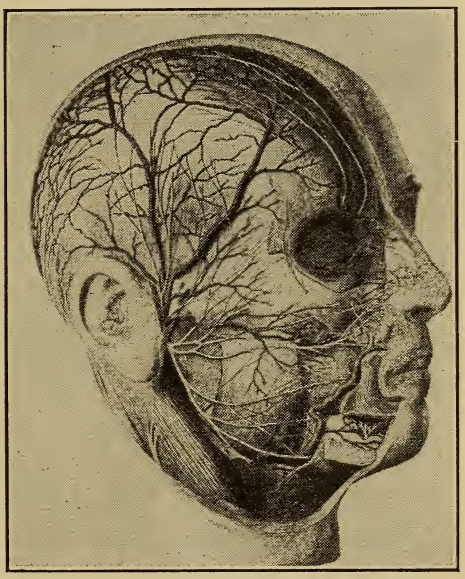


Fig. 136.—Showing distribution of blood vessels and nerves of the side of the head and face. The white lines are nerves. The dark ones, blood vessels.

If one throws a ball, the muscles of the fingers, forearm, arm, shoulder, chest and back all work in unity. If it were not for the plexus of nerves which make it possible for the nerve impulses or messages to these groups of muscles to be in order and regular, the act of throwing a ball would be a failure.

The Sympathetic Nervous System is not a separate nervous system. It is a part of the general nervous system and subject to its control. A **plexus** is part of it.

Ganglia and their connecting nerves complete it. A double row of ganglia (collections of white and gray matter) is placed on each side of the spinal column and branches from the spinal nerves run into them. The ganglia connect with each other and send nerve fibers to the spinal nerves.

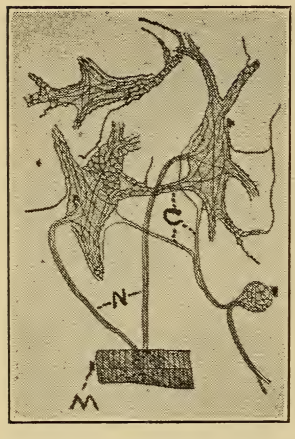


Fig. 137.—Showing nerve connection with a muscle which acts with the aid of the sympathetic nervous system. M. Muscle. N. Nerves to ganglia. C. Connection of ganglia with each other and other nerves.

The function of a sympathetic nervous system is to establish a close working relation of sympathy between many of the organs of the body. For example, when the muscles do heavy work, the heart beats faster, the lungs breathe more air, the sweat glands work, the blood vessels in the skin expand, because the nerve messages to all these organs are harmonized so they may do teamwork. Imagine what confusion there would be if the brain had to **think** to tell each organ what to do, when to do and how to do it.

The sympathetic nervous system looks after all the vital operations of the body. Ganglia are distributed in other parts of the body to insure quick delivery and reception of nerve impulses.

Summary

The brain, the seat of the nervous system, weighing about three pounds, is divided into the cerebrum and the cerebellum.

It is the organ with which we think and are made aware of sensations.

In structure, it is made up of nerve cells forming the white and gray matter.

The cerebrum is the seat of the mind and its nerve cells control the voluntary movements of the body.

The spinal cord is a continuation of the nerve tissue of the brain. It gives off thirty-one pairs of spinal nerves, each having a motor and sensory root.

Many of them in a plexus give off connecting fibers to other nerves to co-ordinate the work of the organs of the body. Nerve cells form all the nerve tissue of the body and by branching they form a network of communication between one another.

Nerves are bundles of nerve fibers, which are enclosed in a sheath. Each nerve fiber retains its identity and performs its own function. A nerve may carry both sensory and motor fibers.

The sympathetic nervous system is a part of the general nervous system and consists of collections of white and gray matter (ganglia), connecting nerves and plexuses of nerves. Their function is to co-ordinate the work of the various systems and organs of the body.

Questions

1. What is the weight of the brain? Its shape? Its location?
2. What forms the left and right hemisphere of the brain?
3. What are convolutions?
4. What does brain tissue look like?
5. What matter forms the convolutions of the brain?

6. What matter is most abundant in the brain?

7. What is the cerebrum? Where is it located?

8. Of what is the brain composed? How do we see, smell, taste and hear?

9. Where and what is the cerebellum?

10. What are the chief functions of the cerebellum?

11. How are we made **conscious** of events?

12. What is an idiot?

13. What is the enlarged portion of the spinal cord called after it enters the skull? What curious arrangement of the many nerve fibers is found here?

14. If the left side of the brain is injured so that paralysis of the body occurs, which side of the body would become useless? Why?

15. How may a blood clot following an injury, produce paralysis? How might such paralysis be relieved?

16. What is the spinal cord? Where is it? What is its length and size? With what does it join at its upper end?

17. Of what matter is it composed? Where is the gray matter found in the cord? Where is it found in the brain?

18. What are the spinal nerves? How many are there? How many roots has each? What function has the fibers from the anterior part of the cord? The posterior part of the cord?

19. Illustrate the action of a nerve from the finger.

20. What is the chief difference between nerve cells and other cells of the body? What is the purpose of this structure? What is a nerve fiber?

21. What is a nerve? What structures compose a nerve? How are nerves distributed to the body cells? How does

the nerve, ending in the body cells, resemble the operation of a telephone in the home?

22. What is meant by a plexus of nerves? What is the need of a plexus of nerves? Illustrate this need.

23. What is the sympathetic nervous system? What are ganglia? What controls this system? What is its function? Illustrate this function.

CHAPTER XXXVI

REFLEX ACTIONS AND HABITS

Voluntary actions start in the brain because the brain wills them to be done. Involuntary or reflex actions are those caused by impulses which start in the nerves and are conducted toward the brain or spinal cord.

The ganglia, spinal cord and medulla are **reflex centers,** that is, an impulse may reach these structures and an action be ordered before the brain has ever received the impulse. One may be walking along a path in a field. A black, crooked object is seen lying across the path. An impulse goes towards the brain carrying the message "There is a snake." The spinal cord gets the message first and sends back a message through the nerves to all the jumping muscles, "Get out of the way of that snake, quick!" The body jumps. The brain by this time has received the message and acts. The black, crooked thing was not a snake. It was only a bent, charred stick. At once the brain sends a message back to the muscles of the leg, "Proceed, you were mistaken. There was no snake; only a stick that looked like a snake."

The first jump was a reflex action. The second act of stepping over the stick was a voluntary action.

Nearly all of our acts are reflex, which is only another way of saying that "We are largely creatures of habit."

We form letters while we write, speak words when we talk, move our legs when we walk, wink our eyes at the appearance of danger, ride a bicycle, use our knives and forks at the table. All of these acts are reflex and are the result of habit.

In the same way, the body may be trained to be erect while sitting or standing, to chew food thoroughly; to keep the teeth, skin and nails clean; to breathe deeply, to exercise daily, to use correct language, to behave properly and to perform most of the daily tasks which make up our lives.

Such habits as these are good and by repeating, over and over, each of them, the nerve cells become so used to ordering them done that the brain finally turns the job over to the spinal cord and ganglia, which continue to do them through life.

Bad Habits are formed in the same way. A great many bad habits are formed because of neglect. It seems so much easier not to do things which should be done than to do them.

Observe which of your friends has teeth that are unclean, decayed and covered with **tartar** and decomposed food. Such a person has neglected to keep the teeth clean.

It is a bad habit with bad results, which a good habit would have prevented.

Perhaps such a person had been washing the teeth, and for some reason one day it was neglected. The nerve cells probably reminded the person several times during the day that some work was left undone. Another time it was easier not to do it, and after a few times the nerve cells were so used to this work not being done that they no longer urged the muscles to perform that task.

People often sit or stand in a stooped or "humped" position, which prevents them from getting as much air as they should have and it makes them grow crooked. The nerve cells become accustomed to the wrong posture

and after a while they offer no protest and give nerve impulses for the wrong position to be kept.

Children often speak incorrectly because they hear often such expressions as "I ain't sick," "Ain't you goin'?" "He wuz there," and many others. The nerve cells become trained to use them, and many times in later life, when one learns to use correct language, much embarrassment may be felt because in an unguarded moment the old brain cells will order one of these incorrect expressions to be uttered by the organs of speech.

One should learn early to use correct language and repeat the effort often until it becomes a **part** of the reflex work of the nerve cells.

Reflex Action and Character. It is through the action of the nervous system that character is formed. As we **think,** we are and do. A character is good or bad, depending upon the training one's nervous system has had.

Repeated training in doing and thinking right, results in the formation of a habit which after a time becomes a reflex action and is performed without great effort of the brain cells.

"Sow a thought, reap an action; sow an action, reap a habit; sow a habit, reap a character; sow a character, reap a destiny." This is a famous quotation, but it illustrates the truth of the action of nerve cells in forming a good or bad habit through reflex action.

"Who will steal a penny in his youth, will steal a pound in his manhood," is a proverb that shows a result of habit and its effect upon character.

A child may be taught to tell the truth and that to tell a lie is shameful and wrong. The first lie that he tells hurts his conscience, but if his training has not been good, he may be induced to tell another and another until

in a few years it seems easier to lie than to tell the truth. But it only seems easier, for by forming this habit of telling untruths, his **character** becomes fixed as being unreliable and his friends discredit him, his business associates fear him and he is really much worse off, though it may seem to him that lying is easier.

The habit of thinking or talking of evil things is dangerous to one because it is only a step from thinking evil to doing it. One would never desire to become a drunkard of the streets, or a gambler whom every one despises. Such people have that kind of reputation because they have repeatedly drunk or gambled until their character is fixed by doing them.

Their **first** acts were not done, however, until after they had **thought** of doing it, maybe, once and quitting. The mind should think only of things which one would like to be or do, that will make a respected and honored man or woman, and then one will do only things which are right and proper and a good character is the reward.

Summary

Voluntary actions result from **efferent** nerve impulses, involuntary actions from **afferent** nerve impulses. Most of the acts of the body are the results of **afferent** impulses and are, therefore, reflex actions. Habits are reflex, and they may be good or bad.

Habits are the result of repeated similar actions of performing, at the direction of brain and reflex nerve cells.

Reflex action is the basis of character. One may not become a gentleman in a day. The character of person is the result of fixed habits.

Questions

1. Where is the origin of voluntary actions? Of involuntary actions?
2. Name three reflex centers. What is meant by reflex centers?
3. Illustrate two reflex actions. Explain why each was an involuntary action.
4. What is meant by saying, "We are creatures of habit?"
5. Name ten actions that become reflex after continued practice, which at first were voluntary.
6. Name seven good reflex actions that one should form to preserve health.
7. How are good habits formed? Bad habits? Give illustrations of three bad habits.
8. Why should one learn early the habit of using correct language?
9. How is character formed? Why is one's character good or bad?
10. What has reflex action of the nervous system to do with formation of character?
11. What famous quotation shows the relation of reflex action and habit to character?
12. What wise proverb shows the result of a bad habit?
13. How is the bad habit of lying formed? Is it easier to lie than to tell the truth? Why?
14. What danger is there in evil thoughts and talk?
15. What is the rule for forming a noble character?

CHAPTER XXXVII

HYGIENE OF THE NERVOUS SYSTEM

The nervous system is responsible for all the activities of the body. It is of the greatest importance to keep it in health. If it suffer, the work of all systems and organs of the body is impaired.

Exercise, good food and air, and regular habits are as necessary to keep the nerve cells in health as they are to keep any of the other body cells well.

Rest and Sleep. The body cells cannot work all the time. They must rest. After hard muscular exercise, rest is necessary. The brain, too, becomes tired from hard thinking and from its work of directing the movements of the muscles, and it must rest to be ready for the next day's work.

Sleep is the state of the body during which all voluntary impulses are suspended and the brain ceases to receive and record sensations. **Consciousness** is lost during sleep. It is at this time that weary brain cells take up nourishment from the white blood cells and recover their energy for work when the brain is aroused from sleep.

The vital processes, as breathing, the circulation, and secretions are kept in operation through the reflex centers of the sympathetic nervous system.

Babies should sleep about eighteen hours of the day; children from the age of five to fourteen should sleep about twelve hours, and adults about eight hours of each day.

Nothing tires one so much, or impairs the health so greatly as the continued loss of sleep. "Keeping late hours" has long been known as the cause of early decay.

Tobacco. The use of tobacco in any form is injurious to the nervous system in many ways. The effects of tobacco on the muscles through the nervous system are such that they tire easily, and cannot maintain contests of endurance. "Unsteady nerves" is an old expression, and only another way of saying that the nerve control of muscles has been impaired. Tobacco causes unsteady nerves, and a "tobacco heart" is caused by interference with the action of the nerves which supply the heart.

The effect on the mind of the use of tobacco is pronounced. As a rule, students who use tobacco habitually have greater difficulty in making as good a showing as others in the same class who do not use tobacco.

Cigarette smoking among younger pupils always produces mental dullness and their nervous system is affected in many ways. Body cells do not multiply so rapidly and the growth of their bodies is stunted many times.

The evil effects of cigarette smoking have been so well recognized that many states have forbidden their sale to young people. Most of the evil effects of tobacco on the various organs of the body are due to the hurtful influence of the poison on the nervous system.

Tobacco poison acts directly on the nerve cells, causing stimulation followed by fatigue. The use of tobacco, especially by young people, creates a false mode of life. They often are restless, nervous, irritable, "hard to please," and usually selfish. Tobacco, therefore, influences the formation of character and the habits it encourages are usually not of the best kind.

Alcohol. In the preceding chapters attention has been called to the evil effects of alcohol on various organs and body cells. Its effects on the nervous system are ap-

parent to everybody who has observed one under its influence.

A drink of whiskey, wine or beer, in one who has not formed a habit causes a giddy feeling in the head. The person often indulges in fast and foolish conversation, but he imagines he is saying "smart" things. His muscles may be very active from the nerve impulses which they are receiving. After a little while the mind begins to be dull, and drowsiness appears. These effects show there has been a powerful effect on the brain cells.

The brains of animals have been examined after they have been given enough alcohol to make them "drunk." When examined, it was found that the nerve cells were shrunken in size and that many of the connecting branches of the cells were injured and almost destroyed.

Long continued use of alcohol destroys brain cells and renders them less useful. The power to think is decreased and the will power is usually weakened.

Its effect on the development of character is very bad, for many times a person under the influence of alcohol, with the will weakened, will do a great many wrong acts which, when free from the effects of alcohol, would be repulsive and disgusting to his better nature.

Probably the worst effect of alcohol on the nervous system is that it leaves a "craving" or "appetite" for more, and as its use is continued, the will power is still further weakened and the appetite increased in its demands.

It is a familiar but sad recollection to think of some young person who, in an evil hour, took his first "drink," and from year to year the number and quantity of his drinks increased until, in the prime years of his life, he became a habitual drunkard.

Alcohol is a poison to the nervous system and in no way may it be considered a food. Its use in the world for a beverage is fast disappearing and many states and countries have prohibited, by law, its sale and manufacture.

Employers of labor which requires a "steady hand and a cool head" are refusing to employ or retain in their employ men who use intoxicating liquors.

The records of courts, houses of reform, and the evils of society are heavy with the evidence that intoxicating liquor is a cause and companion of a large per cent of the crimes and moral wrongs of society.

Summary

The care of the nervous system is important to maintain the efficiency of all of the organs and systems of the body.

Sleep is the rest period for the nervous system. It should be secured every day at regular hours for periods of eight to eighteen hours in twenty-four for infants and adults.

Tobacco is a nerve poison and persistently used has a weakening effect on the mind and muscles.

Alcohol has a disastrous effect on nerve cells and the mind and tends to weaken character. It creates an appetite for itself and weakens the will power for resisting its demands. Its use is being rapidly prohibited by law and it plays a large part in the commission of the sins of society.

Questions

1. Why is it important to keep the nervous system in health?

2. Name three rules of hygiene for helping to keep it in health?

3. When do nerve cells get most of their rest?

4. What is sleep? How much sleep should babies have? Children aged six to twelve? Adults?

5. What is the harm in keeping "late hours" and losing sleep?

6. Name two evil effects of the use of tobacco on muscles through the nervous system? What are "unsteady nerves?" What is the cause of "tobacco heart?"

7. What bad effects may the use of tobacco have upon the mind? What special harm does cigarette smoking have on young people?

8. How may the use of tobacco in youth affect character? Why?

9. What is the effect of a drink of alcohol taken by one who is not "used to it?" What damage has been found to nerve cells of animals which have been made "drunk" on alcohol?

10. What is the effect of long continued use of alcohol on brain cells? On the will power? On character? Why?

11. How does one become a "drunkard?"

12. Why do not employers of labor secure or retain men who indulge in the use of alcoholic beverages? What is the relation of intemperance in the use of alcohol to crime and social evils?

CHAPTER XXXVIII.

THE SPECIAL SENSES

All of our knowledge comes from our experiences which are recorded in the brain. They are gained by our **sensations.**

We have experienced the sensations of heat, cold, hunger. thirst, illness, weight and pressure.

There are five special senses which furnish us with all our knowledge of objects outside of the body. They are feeling, tasting, smelling, hearing and seeing.

If a man were to lose the power of all of these senses, his mind would soon stop thinking and it would be perfectly blank. The loss of one's sight or hearing, or speech is a fearful one and the knowledge and experience of one so afflicted are limited.

All of these special sensations are perceived by the brain through an arrangement of sensory nerve fibers located in special organs. Thus, the sense of tasting is in the tongue; smelling in the nose; feeling in the skin; hearing in the ears, and seeing in the eyes.

The Sense of Feeling is located in the skin. It is most developed in the tips of the fingers, on the lips, and tip of the tongue. Tiny nerve endings are found in the papillae of the skin and when these are brought into contact with an object, they carry to the brain impulses which produce sensations of pain, shape, size, weight, heat, cold, and degree of hardness and smoothness.

One of our first desires upon seeing a new object is to "feel" it, for it is impossible to judge of its weight, consistency or temperature by sight alone.

Pain is one of our most useful of sensations, for by it the body is often protected against injury. Without this sensation, the hand might be laid upon a hot stove and be severely burned before it would be removed. Pain at once sounds the alarm and the body cells are saved by reflex action.

The pain of toothache, illness and of errors in eating or drinking, likewise, may be considered a blessing, because it calls attention to a condition which ought to be corrected. The cause of pain and not pain itself is to be avoided.

Fig. 138.—The tongue, the organ of taste.

Taste. The touch nerves are distributed over all the body, but the special touch nerves which carry the messages of **taste** are located only in the tongue.

The taste nerves have special endings in the outer layers of cells of the tongue, called **taste buds.** A substance to be tasted must first be dissolved. The liquid containing such substance carries it between the taste cells, and a special impulse is carried by the sensory nerve to the brain. If the tongue be wiped dry and a bit of sugar be

placed upon the tip of the tongue, it will not be "sweet" until the saliva has dissolved it and carried it between the taste cells. The sensation of taste may be sweet, sour, bitter, or salt.

Sweet substances are best tasted on the tip of the tongue, while bitter ones are tasted most on the sides and back of the tongue.

The sense of taste is useful; it acts as a guide in the selection of our food, and protects the body from food which might contain dangerous poisons. It may, likewise, be abused for often too much food is eaten because it tastes good. Spices and stimulants to the sense of taste are to be avoided for this reason.

Smell. A special pair of nerves supply the mucous membrane of the front part of the nose with nerve endings which carry impulses to the brain, which produce the sensation of smell. These endings lie between the cells of the mucous membrane and branch out into fine hair-like endings. These nerve endings are called the **olfactory cells.**

A substance can only be smelled when it gives off into the air tiny particles (molecules) of itself. When this air enters the nose in inspiration, these tiny particles come in contact with olfactory cells and the impulses are carried to the brain. Sensations of smell are usually spoken of as pleasant, foul and pungent.

The sense of smell may be made more active by "sniffing" the air into the nose, which brings air in contact with a larger surface of mucous membrane containing olfactory cells.

The Uses of Smell are important. Foul, dangerous, or impure air in a room or neighborhood may be detected by the sense of smell. Decayed food often gives off a bad odor

which the nose is quick to detect and such food is refused admittance into the stomach.

The odor of many foods is quite agreeable and adds to the pleasure of eating and thus promotes digestion of food.

Care of the Nose. Olfactory cells if once destroyed are never replaced. It is important to avoid breathing dust or irritating gases of certain trades because they cause irritation and inflammation of the mucous membrane of the nose, which often results in its destruction and impairment of the sense of smell. "Picking" the nose with the fingers is unsafe for it often damages the delicate lining of the nose, causing the blood to flow and infects it with bacteria which are always found under the finger nails. The dried accumulations in the nose are the result of inflammation of the mucous membrane (catarrh) and they should be softened with pure vaseline and removed by "sniffing" into the nose a bit of warm salt-water made by dissolving a teaspoonful of salt to the pint of water.

A catarrh of the nose should be treated under the direction of a physician for its continued attack often leads to impairment of the sense of smell and other serious conditions.

Summary

The source of all of our knowledge is in the exercise of our organs of special sense in feeling, tasting, smelling, hearing and seeing.

Nerve endings in the skin are the organs of feeling by which form, weight, consistency, temperature, and size of objects are perceived. Pain is a danger signal and is of great value for protecting the body from accidents, decay and illness.

The sense of taste is in the nerve endings of the tongue, which are stimulated by the solution of substances which have taste. Taste is of value in the selection and appreciation of foods.

The sense of smell is located in the front part of the nose where the olfactory nerve spreads its tiny branches in the mucous membrane. The sense of smell adds to our pleasures and is of value in the detection of impure and dangerous air and food.

Questions

1. What is the source of all of our knowledge? Name seven general sensations that all of us have experienced.
2. Name all of the special senses. What would happen to one's mind, if all of the special senses were lost?
3. How does the brain perceive these special sensations?
4. Name the organs of the five senses.
5. Where is the sense of feeling located? How do we feel? What knowledge is gained by feeling? Why do we desire to feel an object?
6. What is pain? What is the value of pain? Illustrate this value.
7. Where is the sense of taste located? How do we taste? Is dry sugar sweet? When is it sweet?
8. What is the value of the sense of taste?
9. What is the organ used for smelling? What part of it is used for this purpose? How do we smell? Why do bird-dogs "sniff the air" when on a hunt?
10. Name four uses for the sense of smell.
11. How may the sense of smell be impaired?
12. What is the danger of "picking" the nose? What is "catarrh"? How should it be treated? Why?

CHAPTER XXXIX

HEARING

Next in importance to the sense of sight is hearing. By hearing is meant the sensation made by impulses in the brain cells which are stimulated through a special pair of nerves (the auditory) by sound waves of the air.

The air is a mixture of gases, and it is always in motion. Every movement that is made creates a wave-like movement in the air. If a room contains smoke, and the arm is waved, the motion of the air may be seen in the movement of the smoke. Such a motion of the arm produces no sensation of **noise** in the brain. If, however, the top of a table is hit a quick, hard blow with a thin board, a noise is heard, because the air has been disturbed so greatly that its waves have made an impression on the nerves of hearing.

When a stone is thrown into the water, waves are made which start at the point where the stone enters it, and are spread in widening circles as the impulses of each wave come in touch with water farther away, and push it along with gradually decreasing force. The waves finally become so wide and shallow that they can no longer be seen.

Waves of air act in very much the same way. If a book is dropped on the floor, at once waves of air are made in all directions and such waves are greatest near the point where the book fell, and as they travel through the air, the waves finally become wider and more faint until the **sound** can no longer be perceived.

The firing of a great gun produces waves of such force in the air that often the ears of a gunner are severely injured. Several miles away these waves become so faint that scarcely a sound is heard.

Sound can be heard if there are at least sixteen air waves in a second but it will have a low pitch.

As the number of air waves increases in each second, the sound becomes higher in pitch. A scream of a voice, or the sound of a shrill whistle, is caused by very rapid movement of air waves, and when the number of such waves exceed 40,000 per second, sound can no longer be perceived.

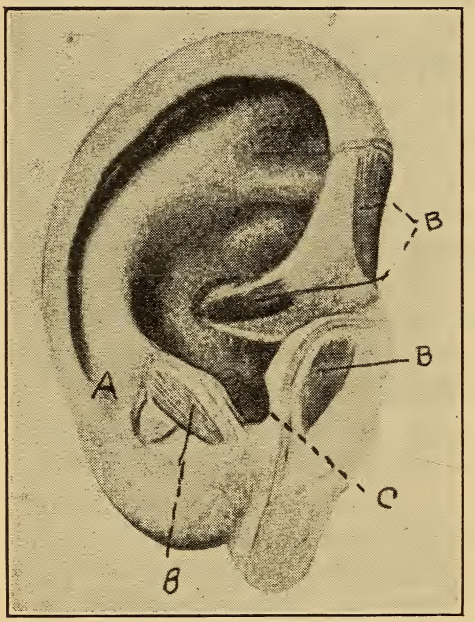


Fig. 139.—The external ear. A. Folded cartilage. B. Tiny muscles. C. Opening into auditory canal

Pitch in sound, as in music or talking, depends upon the rapidity of movement of air waves or sound waves which reach the ear.

The Organ of Hearing is the ear, one on each side of the head. Each ear is made up of three parts; the **external** or outer ear, the **middle** ear; and the **internal** ear.

The Outer Ear is a peculiarly folded piece of cartilage covered by skin, and a tube or canal (auditory) which

leads to a whitish membrane (tympanum) stretched across it like the head of a drum. The tympanum is commonly called the "drum" of the ear.

The function of the external ear is to catch the waves of sound and carry them to the drum. Its shape reminds one of a horn with a large opening leading to the auditory canal. Persons who are slightly deaf often insert a large metal horn into the ear to assist it in catching more of the sound waves.

The auditory canal is kept soft with a kind of wax secreted by the skin.

The Middle Ear is a hollow in the bone (temporal) in which are three tiny bones joined together, forming a chain. One end of the chain is attached to the drum, the other reaches to the internal ear. On account of their shape these bones have been called the hammer, anvil, and stirrup. The three of them would weigh no more than a small grain of wheat. From the middle ear a tube runs to the back of the throat (the Eustachian tube). Its function is to admit air into the middle ear so that the air pressure on each side of the drum may be the same. If unequal air pressure exists, the action of the three bones is hindered and defective hearing is the result.

When one dives under water, a bit of deafness is often noticed upon reaching the surface. If one "swallows," this feeling at once disappears because air has entered the middle ear from the back of the throat and the air pressure is made the same on each side of the drum.

At times, following "colds," la grippe or similar infections, the Eustachian tube becomes closed, with impairment of hearing, and it may become necessary to secure the services of a physician to open it again.

The Internal Ear lies in a cavity deep in the temporal bone and is entirely filled with fluid in which are the tiny ends of the auditory nerve. The fluid is prevented from escaping into the middle ear by a tough, thin membrane.

The internal ear is about seven-eighths of an inch in its entire length and for convenience is described in three parts: The middle part (the vestibule) connects with one of the bones of the ear (stirrup), which is attached to a thin, tough membrane. The front part (the cochlea) is shaped like a snail shell. It is in the cochlea that the auditory nerve divides into tiny, hair-like ends which receive the impulses caused by the sound waves. The remaining part (the semicircular canals) is made up of three loops, each of which is filled with fluid. These canals aid one in keeping his balance through reflex action of the muscles. If one turns around rapidly several times, he becomes "dizzy." It is caused, most likely, by a disturbance of the fluid in the semicircular canals.

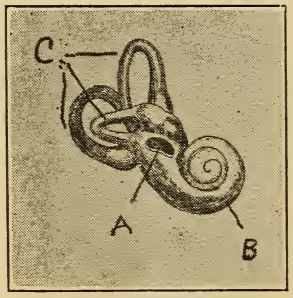


Fig. 140.—The internal ear. A. The vestibule. B. The cochlea. C. The semicircular canals.

How We Hear. The waves of sound enter the external ear and strike the ear-drum which is made to vibrate exactly as a head of a drum which is beaten with a stick. The drum, attached to one of the tiny bones (the hammer) causes this bone to move to and fro and this motion is carried along the chain of bones to the "stirrup" which is attached to the membrane of the internal ear. The movement of this membrane sets in motion the fluid

of the internal ear, which stimulates the delicate hair-like ends of the nerve of hearing. These nerve impulses are carried to the brain and a sensation of noise is produced. What a wonderful piece of machinery is this delicate arrangement by which noises ranging from the roar of cannon to the sweetest notes of music may be recorded in the brain!

Care of the Ear. Sometimes wax accumulates in excess in the external canal and may cause a dry cough and slight deafness or pain in the ear. It should not be removed with a pin or other hard substance for the skin may become infected or the drum may be injured. It is best to have it removed by a physician.

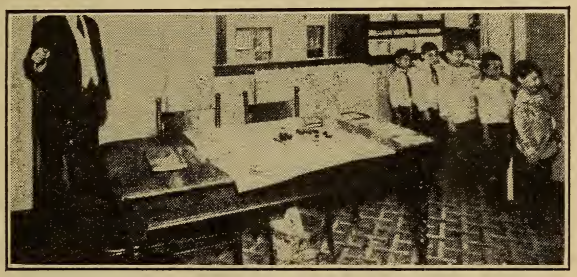


Fig. 141.—Testing the hearing in pupils by the use of a watch.

The middle ear often becomes inflamed following colds and like infections, and "earache" results. It is very painful and unless hot flannels applied to the side of the head relieve the pain in a few hours, a physician should be called.

"Running ears" are the result of an inflammation in the middle ear, which has produced an abscess. The accumulated pus has burst the drum membrane and the loss of hearing may result if it is not properly treated under the direction of a good physician.

Sometimes this inflammation spreads into the bone be-

hind the ear causing intense pain and high fever. An operation is then most often necessary to chisel through the outer layer of bone and free the pus.

Loud and unexpected noises should not be produced close to the ear, for such sound waves may impair the delicate structure of the ear or even rupture the drum membrane.

Summary

Hearing is the sensation produced in brain cells through the auditory nerves which are stimulated by sound waves through the ear, the organ of hearing.

Sound waves vary in intensity depending upon the number of vibrations per second, and produce a noise of low, medium or high pitch.

The external, middle and internal ear are intimately connected so that sound waves are received, transmitted and regulated for their reception by hair-like ends of the auditory nerves.

The ear, being a delicate and complex piece of machinery, should not be neglected when inflamed or injured but at once should be treated by a physician, skilled in its care.

Questions

1. What is hearing? What is the nerve of hearing? What is noise?

2. Why does not a motion of the arm produce a noise? Why does the ringing of a bell make a noise?

3. Explain the action of water when a stone is thrown in it. Explain the action of air when a gun is fired. Why can not a sound be heard at any distance?

4. What is the least and greatest number of vibrations of air that produce sound, which the human ear can detect? What is pitch?

5. What are the organs of hearing? What is the external ear? What is the tympanum? What is its common name? What is the shape of the external ear? Why? What is the use of all the "wrinkles" in the outer ear?

6. What is the purpose of "ear wax?" How may it produce trouble?

7. What is the middle ear? What does it contain? How large are the bones of the middle ear?

8. What is the Eustachian tube? What is its purpose? Illustrate its use.

9. How do colds and la grippe often affect hearing? How may relief be obtained through a physician?

10. What is the internal ear? With what is it filled? How many parts has it? How is it connected with the middle ear?

11. What is the cochlea? What is its function?

12. What are the semicircular canals? What is their function? Illustrate this.

13. Explain how one hears.

14. What three bad effects may an accumulation of wax in the ear produce? What is the remedy?

15. What is "earache?" What is the cause and danger of "running ears?" Can an ear "run" unless the drum is ruptured? Why? What serious result may follow an abscess in the middle ear?

16. How may sudden and loud noises affect the ear?

CHAPTER XL

SEEING

Probably the most serious misfortune which might befall a person would be the loss of sight. A person who is blind is in darkness all of the time. Familiar scenes, the reading of books, and the recognition of the faces of friends and loved ones are lost forever.

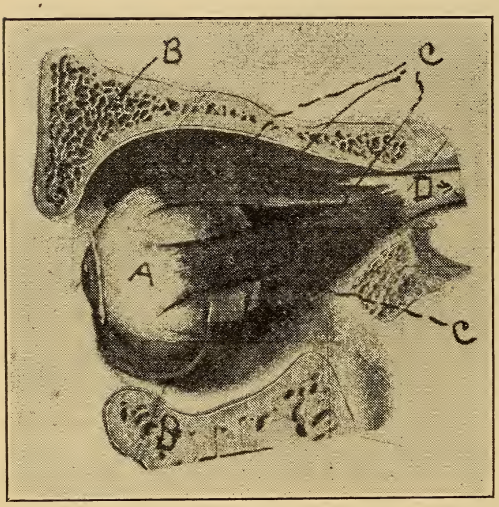


Fig. 142.—The eyeball protected by its bony socket in the skull. A. Eyeball. B. Bones of the skull. C. Muscles of the eye. D. Optic nerve.

The organs of sight are the eyes, which are located in the bony sockets of the skull.

The Eyelids. The upper and lower eyelids protect the delicate membranes of the eye and on their edges are rows of curved hairs which prevent much dust and foreign matter from entering the eye. The inner surface of the lids and the surface of the eye which they cover are kept moistened with a fluid, the **tears.**

The tears are secreted by the lachrymal glands which are just under the bony ridges at the outer end of the eyebrows.

The Eye is a spherical shaped body about one inch in diameter. It is almost round like a marble, except at the front side where its surface bulges out. It is surrounded by a mass of fat, muscles, and connective tissue and moves freely by the action of its muscles.

Six muscles move the eyeball, one is attached at its upper and lower sides and one at its inner and outer

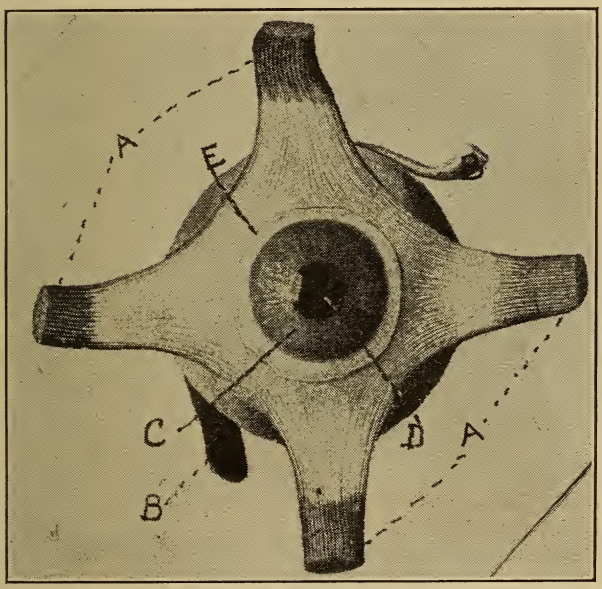


Fig. 143.—The eyeball viewed in front. A. Muscles to move the eye up, down, in and out. B. Muscles to roll the eye. C. Iris. D. The pupil. E. Union of the sclerotic coat and cornea.

sides and two are so attached that the eyeball can be rotated or turned in any oblique direction.

It is by action of these muscles that we look up and down, sidewise, either in or out, or roll the eyes around.

The eye in front is provided with a window through which the light enters. It is a perfectly transparent membrane (cornea) and it joins the white membrane (sclerotic) of the eyeball.

The "color of the eyes" is due to the coloring matter in the curtain (iris) which is seen just inside the eye. The **pupil** is the round hole in the curtain and it admits light into the deeper parts of the eyeball. The pupil sometimes is large and again small. In very bright sunlight the pupil is least and in darkness it is largest in size. The function of the iris, which is supplied with tiny muscles to regulate the size of the pupil, is to admit just enough light into the eye to see best. If the eyelids are closed for half a minute and suddenly pulled open, the pupil may be seen to become, at once, smaller.

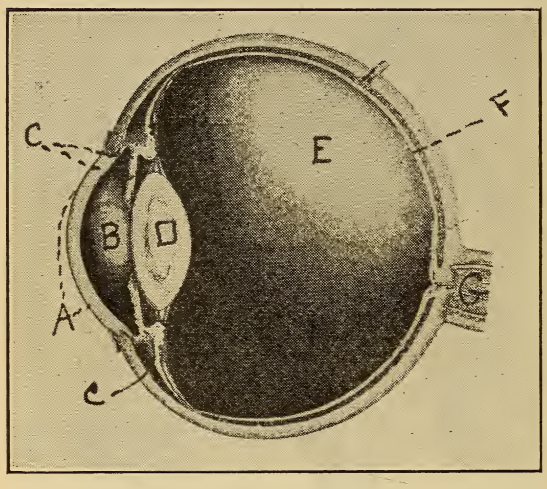


Fig. 144.—A cut through the eyeball from the front to the rear and from above down. A. Cornea. B. Chamber for aqueous humor. C. Iris. D. Lens. E. Space for the vitreous humor. F. The retina. G. The optic nerve.

Between the cornea and the iris there is a small chamber filled with a perfectly clear fluid, the **aqueous humor.**

Just back of the pupil is a lens which, like one in a camera, is used to bring all the rays of light entering the eye to one point.

The lens (crystalline lens) permits the light to pass through, and by the action of its tiny muscles, its shape can be so changed that the rays of light will be brought together at one point. Have you ever used a reading glass to burn a hole in a paper by holding it towards the sun and moving it back and forth until the light would all be in one bright, fiery spot? The lens of the eye works very much in the same way. If we look at this page and at once look across the room, there will be noticed a change of some sort which occurred in the eye. The change consisted in the action of the muscles of the lens which changed its shape so that the rays of light were brought to one point (a focus) in the back of the eyeball. The lens is made thicker to see objects near the eyes, and its muscles must make it thinner to see objects farther away.

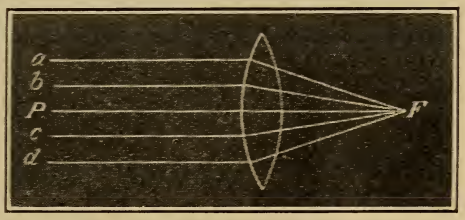


Fig. 145.—Showing how a lens brings parallel rays of light A, B, P, C, D, to a focus as at F.

The eyeball is filled back of the lens with a thick, dark colored fluid (the vitreous humor). At the rear of the inside the special nerve of sight (optic) enters the eyeball and spreads out in a wonderful network of fine branches which form the inner coat (retina) of the eye.

How We See. Have you ever thought what light is? It is by means of light that we see. No one can see in absolute darkness.

Ether is the name of a substance which fills all empty space. It is between the molecules of air, wood, stone and steel. It reaches the moon, sun and stars. Light is the waves of ether in motion. When we look at a burning match, or any object, the waves of ether are in motion and they enter the eyeball through the cornea, pass through the pupil of the iris and the lens, which changes its form so that the waves of ether (or rays of light) are brought to a point (focus) on the tiny nerve endings of the retina on the back wall of the eyeball. These waves of ether stimulate the nerve fibers of the optic nerve, the

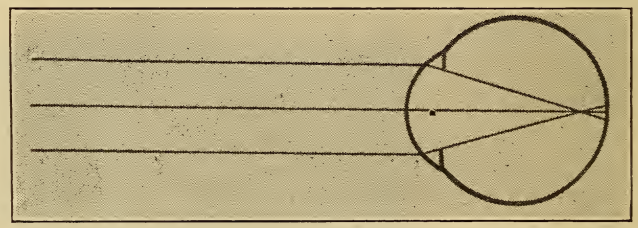


Fig. 146.—Showing how the rays of light are focused before they reach the retina as in near-sightedness.

impulse is carried to the brain cells and by their action we perceive the sensation of sight.

Near-Sightedness is a defect in the eye which causes a blurred or indistinct image. A near-sighted person holds the eyes close to the object to be seen. The rays of light entering the eye are brought to a focus in front of the retina instead of upon it. A competent oculist is often able to correct this defect by ordering special lenses of glass to aid the crystalline lens in focusing the rays of light on the retina. Such glasses or "spectacles" should be worn during the working hours.

Far-Sightedness is a defect in the eye by which rays of light are unable to be focused upon the retina because

it is too close to the lens. People who are far-sighted, when reading, hold a book far away from the eyes. This condition can be corrected by wearing glass lenses of

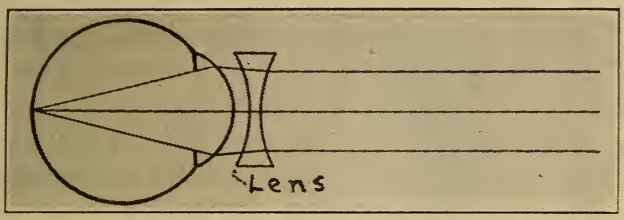


Fig. 147.—Showing how near-sightedness may be relieved by wearing the proper glass or lens.

such a shape that the lens of the eye can bring the rays of light to a focus on the retina.

Astigmatism is a defect of the eye caused by a flattening or irregularity in the curve of the cornea. Part of an image may be perfectly focused on the retina but the rays of light entering at the defect in the cornea are imperfectly focused and a blurred image results. A competent oculist is able to order a glass lens which corrects

Fig. 148.—As in far-sightedness, shownig how the lens fails to bring the rays of light to a focus on the retina.

this defect and perfect vision results. Such glasses must we worn through the day, otherwise the headaches and pain in the eye caused by the astigmatism may return.

A Cataract in the eye is a lens which no longer permits the rays of light to pass through undisturbed. The lens becomes milky white, hardened and finally becomes opaque, so that no light enters the eye and blindness results. In most cases the lens can be removed by a skilled oculist and glasses fitted so that good vision may be obtained.

Care of the Eyes. It is plain that the eye is the most delicate of the machinery of the body. Its good work depends largely upon good health and proper care.

The eye should be examined for defects, if upon reading, sewing or using them constantly for an hour or two,

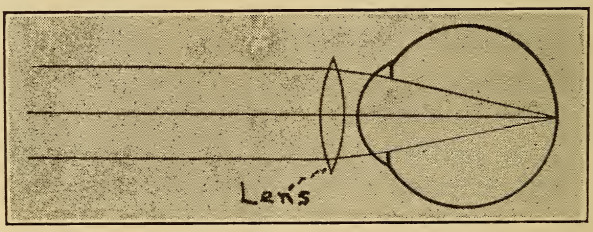


Fig. 149.—How a properly fitted glass or lens may correct the condition of far-sightdeness.

a headache or pain in the eyes is felt. If a book is held too close or too far away from the eye by a person, he should have the eyes tested for near or farsightedness and properly fitted glasses should be worn.

Many so-called dull pupils in school are not really dull but have a defect in the eyes which causes them to see poorly. The right kind of glasses relieves such conditions at once. When reading or working at a task which requires constant use of the eyes, care should be taken to have the light fall over the shoulder and not let it shine directly into the eyes.

Eye Strain is the result of too long continued use of the eyes, or their use in a poor light, or while facing too strong light. Reading on a train or in an automobile is injurious because the motion of the car causes varying distances between the objects and the eye, and the delicate muscles of the lens are constantly at work and on a strain to keep the images properly focused.

Fig. 150.—Testing the eye for defects by reading letters twenty feet distant.

When a long period is needed for work with the eyes, it is wise to rest for a few minutes so the muscles of the eye may relax and be ready to resume work with less fatigue. Reading while lying down is injurious because too much blood flows to the head and the eyes become reddened and eye strain with headache frequently results.

Cross Eyes are sometimes due to a defect causing nearsight or farsight in one eye or the other. In such cases glasses fitted early may cause the eyes to become straight. In some cases it may become necessary to have a surgeon operate upon the eye so that the muscles may pull the eye to its proper position.

Summary

The loss of the sense of sight is so terrible that great care should be used to protect its organs, the eyes, from injury.

The eyelids with their hairs and the tears protect the eyeball from foreign bodies.

The eye is almost a sphere and moves freely by the action of its six muscles in its bed of fat, muscles, and connective tissue. The cornea is the transparent window in front through which the iris and its opening, the pupil, may be seen.

The lens is transparent, and is so arranged that by the action of its controlling muscles, it may change its shape to bring the rays of light to a focus on the retina or nerve of sight in the back of the eyeball. The chamber back of the lens is filled with vitreous humor.

Sight is a sensation perceived in the brain when its cells are stimulated by impulses coming through the optic nerve from its end in the retina which has been stimulated by focused rays of light.

Near and farsightedness are caused by defects in the eye which prevent the lens from bringing rays of light to a focus on the retina. The condition can be relieved by wearing properly fitted glasses.

Astigmatism is caused by a defect in the cornea and it may be relieved by glass lenses.

A cataract is a lens which has become more or less opaque and may cause blindness. When it is removed by a surgeon and glasses are fitted to the eye, sight is usually restored.

Defects of the eye are frequent and cause eye strain, headaches, nervousness, and many other distressing conditions.

The eye should be examined when trouble is suspected and defects corrected.

Using the eyes too long at a time or in poor light or while facing a light or lying down or while reading in a moving car may result in eye strain.

Questions

1. Why is the loss of sight so terrible?
2. What are the organs of sight?
3. What are the functions of the eyelids? What are tears? What is their purpose? How are tears formed?
4. What is the shape of the eye? How is it protected from severe injuries? What tissues surround the eye?
5. How many muscles supply the eyeball for its movement? How are they arranged?
6. What is the cornea? What is its function? What is the "white" of the eye?
7. Where is the aqueous humor? What is its color?
8. Where is the lens of the eye? What is its function? What is meant by bringing rays of light to a focus? Illustrate this.
9. Is the lens the same shape in your eye while you are reading this question as it will be if you look at the far end of the room? Why? What change is made in the shape of the lens when objects farther away are seen?
10. What fills the back part of the eyeball?
11. Where is the optic nerve? How is it arranged in the eyeball?
12. Where is ether? What is ether? What is light? Describe how we see.
13. What is near-sightedness? How may it be relieved? How may one suspect near-sightedness?

14. What is far-sightedness? How may it be relieved?
15. What is astigmatism? Can it be relieved? How?
16. What evil effects often follow defects in the eye?
17. What is a "cataract?"
18. What are danger signals of eye strain? What should be done if such defects are believed to be present?
19. How should light be directed when the eyes are at work? Why?
20. Name five causes of eye strain.
21. What is the advantage of a rest period for the eyes?
22. What is sometimes the cause of crossed eyes? How may they be straightened?

CHAPTER XLI

EMERGENCIES

Injury by Violence. The body is often injured by cutting, pointed or dull instruments, as knives, saws, nails, clubs and stones. These injuries may be cuts, punctures or bruises, and they may be slight or severe. Slight cuts may be treated at home. It is safe to assume that the common pus germs have gotten into the cut. The object of treatment is to remove dirt and germs from the wound, bring its edges together and hold it by a dressing until nature can heal the injury.

With clean hands the skin about the cut should be washed clean. A bit of soft cloth or absorbent cotton may be wrapped around a splinter or toothpick, dipped in a ten per cent solution of iodine (tincture of iodine) and inserted into the cut to its greatest depths. The iodine usually will kill any bacteria in the wound. The edges of the cut should then be pinched together, a piece of clean, white cloth placed over it, and a strip of **adhesive plaster** placed across the cut so that the edges of the wound may be kept close together. Unless there is much pain, redness or swelling the dressing should remain in place four or five days.

If inflammation develops, the dressing should be removed and the wound washed with warm, clean water and soap and redressed. Severe cuts or wounds which become painful and sore with a discharge of pus, should be treated by a physician.

Punctures are usually made by a knife blade, nail or splinter, and may be deep or shallow. Punctured

wounds received around the barns and stables are apt to result in lock-jaw (tetanus). Every accidental punctured wound should be regarded as already infected by some kind of germ. It should be treated like cuts and it must be certain that the cotton soaked in the iodine, on the toothpick, has been pushed all the way to the bottom of the wound, and it is well to repeat this two or three times. Ordinary turpentine is often used instead of iodine, but it is not so effective.

If such a wound is caused by stepping on a nail about the stable and it is deep, it is wise to consult a physician, who may find it necessary to cut open the wound, clean it and give a serum to prevent the development of lock-jaw (tetanus).

Bruises may be caused by falls or blows. The skin may not be cut, but the tissues beneath and even a bone may be severely damaged. If a bone is broken, it should be treated by a physician. The pain of bruises may be relieved by the application of several layers of woolen cloths wrung out of hot water. They should be changed frequently. The injured part should be kept at rest. Rubbing the part with camphor (spirits) or some other **linament** often helps to relieve the soreness.

Bites of Animals and Stings of Insects. Dog bites are frequent and may result in a cut or punctured wound or a bruise. These wounds should be treated as already described. If the dog which inflicts such a wound is "mad" (suffering with a disease, hydrophobia or rabies) the person bitten is in grave danger of contracting the disease.

Unless it is known at once that the dog is "mad," it should be confined for about two weeks and watched. If it act peculiarly, froths at the mouth, has a fit of trembling when water is offered it, or bites savagely at

objects around it, the dog is most surely a victim of rabies. It should at once be killed without injury to its brain. The brain should be sent to a laboratory, where certain kind of "bodies" will be found, if the disease is present.

If the dog has been killed at once after biting a person, its brain should be examined for the "bodies" (negri). A person bitten by a rabid dog or other animal should at once take the **Pasteur Treatment.** This takes about twenty-one days and is practically certain to prevent the disease, with no bad results when it is properly given.

The so-called "mad-stones," which many people imagine are of value in "sucking" the poison from such wounds, are of no value, and their use may prevent the victim from taking the **Pasteur Treatment.**

Certain **insects,** as honey and bumble bees, wasps, hornets and "yellow jackets" often sting a person in defense of their nests or life. The acid in the sting is very painful but not dangerous unless a large number of such insects make the attack at one time. An application of common cooking soda and cloths wrung out of cold water help to relieve the pain.

Burns and Cold A burn may be caused by an open flame, a hot surface, a chemical or by electricity. In any case, the skin may be reddened or "blistered" or entirely destroyed. In burns with reddening of the skin and unbroken "blisters," cloths wrung out of cold water in which cooking soda is dissolved help relieve the burning pain. If the air can be kept from the burned spots, the pain is much less, and several folds of woolen cloth wrapped about the part gives relief for this reason.

If a burn has destroyed the outer layers of skin and

the "raw" surface is exposed, the burned spot should be covered with an oil of some kind. Pure vaseline applied thick is of value. Equal parts of **lime water** and **linseed oil** make a good oil dressing. A soft piece of clean **gauze** or cloth of several layers is laid over the burn and this mixture is poured over it. Several layers of cloth are then applied to help exclude the air. These dressings should be changed every day.

A severe burn or simple burn of large size should always be treated under the direction of a physician.

Cold often injures the skin or deeper tissues, depending upon the degree of cold and the length of time the body has been exposed.

Frost Bites of the ears, nose and toes are common. The skin at first looks "whitish" and pain may not be noticed until one has been in a warm room for some time; then it is severe.

The parts should be rubbed with cold water or even snow, and gradually brought near the fire. The skin capillaries may be destroyed if heat is directly applied to a frozen part of the body.

A severely frozen part of the body, as the hands or feet, should be treated by a physician, and the parts kept from the heat until he arrives.

Electric Currents may produce burns which should be treated as other burns. In cities where electricity is carried by wires or cables, one may be "shocked" by coming in contact with such a "live" wire. If there is enough current the victim may be unconscious and the wire may still be in contact with the body. If the wire is not properly removed the current may enter the body of the rescuer. Such wires can be safely handled with good rubber gloves or folded silk of sufficient thick-

ness. The victim should be removed to a warm, dry room and should receive the attention of a physician at once.

Sunstroke occurs usually in the hot summer months as a result of the intense heat of the sun. Firemen of great boilers and workers about fiery furnaces of foundries may have a similar condition at any time. The victim falls in a faint. The skin is burning hot and the heart beats rapidly. He should be removed to a cool spot, the clothing loosened and given plenty of fresh air. The heat of the body must be reduced at once and cold water should be poured over the victim and the hands and face bathed in cold water. In a little while he may revive and he should be kept in bed for a few days.

To prevent sunstroke, light, cool clothing and hat should be worn. Upon feeling dizzy, hot or fainty or a severe headache, one should at once seek a cool place and rest for a while.

Heat Prostration is also caused by intense heat. In this condition the body is not intensely hot and the face flushed. The victim is weak and almost exhausted. The heat of the body is low, and the patient will be pale and faint. He should be removed to a cool spot, laid upon the back, and the hands and feet rubbed until the blood circulates freely. The face and head should be bathed with **warm** water and when able, the victim should drink hot tea, coffee or milk. Heat prostration may be prevented in the same way as sunstroke.

Summary

Injuries by violence comprise cuts, punctures, bruises and may be inflicted by sharp, pointed, or dull instru-

ments. The object of treatments is to free the wounded parts from infection, restore and keep them at rest until they may be healed.

Tetanus or lock-jaw may follow wounds that exclude the air. A serum may be given to prevent it.

Rabies is a dangerous disease that may follow the bite of an animal so afflicted. Its brain should be examined in a laboratory and if negri bodies are found, the **Pasteur Treatment,** which requires about twenty-one days, should be given to the victim.

Burns and cold may destroy the skin and deeper tissues. Simple burns should be treated by applying a soothing dressing and excluding the air. Frost bites and freezing of the body require careful attention to keep the frozen body cells from dying.

Electric currents may produce burns which are treated as ordinary ones.

Intense heat may cause "sunstroke" or heat prostration. The former is treated by cooling the blood quickly; the latter by applying stimulation to revive a faint and weakened body.

Questions

1. How may the body be injured by violence? What three kinds of injuries are most common?

2. What three objects are there in treating cuts?

3. Describe how you would treat a cut across the arm. Why should the hands of the person who dresses the wound be clean? What is the reason for using iodine? How should it be used? What is the purpose of putting adhesive plaster across the line of the cut? How long should such a dressing remain on the wound? What would lead you to change it? When would you send for a physician to treat a cut?

4. What are "punctured" wounds? How would you treat a punctured wound made by stepping on a nail? What special danger may there be in punctured wounds?

5. How may tetanus (lock-jaw) be prevented?

6. How should bruises be treated?

7. How should the wounds caused by the bite of dogs or other animals be treated? What is the danger after being bitten by an animal? What is hydrophobia? Rabies? What signs in an animal would lead you to think it was "mad?" What is the final proof that an animal has rabies?

8. What is the prevention for rabies? How long does it take to complete it?

9. What are "mad-stones?" Are they of any value?

10. How would you treat the sting of insects? Name five insects that sting.

11. How may burns be caused? What are the three extents of a burn? What are the objects in treating a burn? How should a burn be treated if the skin has been burned off?

12. How may cold injure the body? What are frost bites? How should frost bites be treated? What would you do if you found a person with frozen hands or feet?

13. How should burns caused by electric currents be treated? What effect may heavy charges of electricity have on the body? How may "live" wires carrying a heavy charge of electricity be handled without danger?

14. What is the cause of sunstroke? How does it affect a victim? What would you do if you saw a person have a sunstroke? How could you tell it was a sunstroke and not a heat prostration?

15. How would you treat a person who was suffering from heat prostration?

CHAPTER XLII

EMERGENCIES (Continued)

Fainting is somewhat alarming, but is seldom dangerous. A person about to faint becomes very pale, weak and dizzy and suddenly falls unconscious. The blood rushes away from the brain centers and accumulates in the large blood vessels of the body.

The treatment of fainting consists in bringing blood quickly back to the brain. The person may be laid flat on the floor, the clothing loosened, the arms and feet rubbed vigorously, and cold water sprinkled on the face. The quickest way to revive such a person is to turn the body so that the head and shoulders are lower than the rest of the body. The simplest way to do this is to set the patient in an ordinary chair and tilt it backwards until the back of the chair and head of the patient are on the floor and the feet and limbs are then on a higher level than the rest of the body. In this position, blood quickly rushes to the head and the patient soon revives.

Fits is a name applied to a condition of a person who at intervals becomes unconscious, with convulsions or jerking of the muscles of the body. Such a person is said to have epilepsy, and he is in danger of injuring himself by falling.

It is alarming but death rarely results unless it is by injury from falling.

The victim should be given plenty of fresh air and prevented from injuring himself by the convulsive movements of the muscles. The tongue often gets between the jaws and may be severely chewed unless a tightly

folded handkerchief, cork, rubber or some similar object is inserted between the teeth.

Asphyxiation may result from breathing natural or illuminating gas, carbon-dioxide in a well or cellar, or by accident in which the supply of air is used up, or by drowning.

In any event, the victim is unconscious, the skin cold, the body limp; no breathing can be seen and the heart's beat can hardly be felt.

The only way to save the life of such a person is to try to make him breathe again.

This is done by **artificial** respiration. The best method of doing this is to lay the patient flat on the floor or ground, on his chest and stomach, face downward. The head should be turned to one side. The person who is going to do the work kneels astride the victim at the hips and places the hands, palm downwards, across the small of the victim's back and lets the fingers extend around the lower ribs, with the thumbs almost together.

The operator now swings his body forward and with his weight presses downward on the lower part of the chest, which forces the air, gas or water out of the victim's lungs. He then swings his body backward, keeping his hands on the back, and the air rushes into the lungs of the victim. This operation should be repeated about eighteen times every minute at regular intervals, and it should be continued for two or three hours or as long as there is the least sign of life. After drowning, when death seemed certain, life has been saved after four hours of such work of artificial respiration.

The victim's hands, legs and body should be vigorously rubbed, and the body kept dry and warm.

Poisons are of many kinds but, fortunately, the principles of treatment, until the doctor comes, are few.

The first things to do are: To call a doctor; to get the poison out of the victim's stomach in the quickest time; to give something which will "kill" or make harmless the poison in the stomach; to fill the stomach with something to keep the tissues of the stomach and bowels from being destroyed by the action of the poison, and to keep up the patient's strength until the effects of the poison have passed away.

An **emetic** is a drug or substance which will cause the stomach to force its contents out of the mouth, by vomiting. Sometimes a stomach pump is used for this purpose.

A **purgative** is a drug or substance which will cause the stomach and bowels to move the waste materials through the body.

An **acid,** when swallowed, destroys the body cells of the mouth, the tube to the stomach, and the walls of the stomach. An acid may be made almost harmless if an alkali can be given early enough. Vinegar, a sour **acid,** can be **neutralized** by adding to it common cooking soda, an **alkali.**

Alcohol is often taken in too large doses, so that stupor, "drunkenness," results.

An emetic should be given, or the physician may use a stomach pump. Hot coffee, tea or milk will help restore the victim.

Acids, such as muriatic, nitric, sulphuric, if swallowed, should be neutralized by drinking a glass of lime water with much free lime in it, followed by the whites of eggs to protect the stomach wall.

Carbolic acid poisoning is best treated by giving the victim alcohol, which neutralizes the effect of the acid. Whites of eggs are given to protect the stomach.

Alkalis, as "concentrated" lye or potash, may be neutralized when swallowed, by giving weak vinegar. It should be followed by a half glass of castor oil and milk.

Arsenic is sometimes found in rat poison or coloring matter of wall paper. When swallowed, the victim should be given warm water and mustard, a teaspoonful of mustard to the pint of warm water. Let the victim drink this until vomiting occurs. Milk and the whites of four or five eggs should be given.

Bichloride of mercury poisoning should be treated by giving an emetic, and, at once, milk and the whites of eggs.

Camphor, chloral, gasoline, lead poisoning, matches, morphine, strychnine and turpentine poisoning should be treated by giving an emetic, and stimulants, such as hot coffee, tea and artificial respiration, if necessary. Iodine poisoning should be treated by giving an emetic, and starch water or flour and water mixture, and whites of eggs.

CHAPTER XLIII

COMMON DISEASES OF CHILDHOOD.

There is a group of diseases which are spoken of as "catching." By this is meant that they may spread rapidly among persons who come in close relation with one sick of these diseases.

They occur most often in childhood and young life, but older people often suffer from them.

Diphtheria, scarlet fever, whooping cough, infantile paralysis, chicken-pox, and measles are the most common ones and a great many young people and children are ill each year and many of them die from one or more of these diseases.

They are spread from person to person by germs or seed which escape from the person who is sick, and grow in the bodies of others who are exposed to them.

In all of these diseases, it is the duty of the family to try to keep the disease from spreading. This may be done by allowing no visitors in the sick room, keeping the victim at home until every trace of the disease is gone, and using the proper care in nursing so that the disease germs which escape from the body are promptly killed.

In treating each of these diseases the victim should be kept alone in a well-lighted and ventilated room properly screened. There should be no rugs or carpets on the floor and all the eating and drinking utensils of the patient should be promptly boiled. Only one person should nurse the patient and the members of the family should not be permitted in the sick room.

At the close of the illness, when all danger of infection is over, the bed-clothing should be boiled or **disinfected.** The floors and woodwork and doorknobs should be scrubbed in a strong solution of lye or a bicloride solution made by dissolving 60 grains of bicloride of mercury in a gallon of water. Both of these solutions are poisonous and should be carefully guarded to prevent some one from accidentally swallowing them. The walls of the room should be rubbed with a cloth or a broom, which is moist with the bicloride solution.

Diphtheria is one of the common infectious diseases of early life and childhood. It is a germ disease and develops in the nose, in the back of the throat, or tonsils and in the larynx. Diphtheria of the larynx is also known as "membranous croup."

The patient has fever and a rapid pulse; the throat is usually "sore" and a whitish membrane grows at the site of the disease.

If seen early, a large dose or two of antitoxin (5,000 to 10,000 units) will usually cure the disease. The longer the disease is permitted to continue before antitoxin is given, the greater danger there is of death.

Antitoxin is harmless and its only danger is in not being used early, often enough or in large enough doses. A small dose (1,000 units) given to every other member of the family will usually prevent it from developing in them. One attack usually makes one immune from it afterwards. After exposure to diphtheria, the disease may develop in another person in about five days. The discharges from the nose and throat contain millions of the seed of the disease and they should be caught on cloths wet with carbolic acid solution (2 tablespoonfuls to a pint of water) and promptly burned.

Scarlet Fever is a serious disease which causes high fever and sore throat, followed by a "breaking out" of the skin. The skin looks red and flushed and the eruption of "rash" appears about the second day of the disease. The discharges from the nose and throat contain the infection and they should be collected and destroyed as in case of diphtheria. The patient should be carefully protected from cold and "drafts," for the great danger from this disease lies in the after-effects on the kidneys and middle ear.

About three to five days are necessary for a new case to develop after one is exposed to scarlet fever. One attack usually produces an immunity against other attacks.

Whooping Cough is a serious disease occurring most often in children. It runs a course of several weeks, and is known by its peculiar cough, which sometimes leaves the victim almost out of breath and ends with a loud "whoop" which when once heard is never forgotten.

The infection is spread from the nose and throat, and all materials escaping from the nose and mouth should be at once destroyed as in diphtheria and scarlet fever. This disease appears in about twenty-one days after one is exposed to a person having it, and an attack usually confers immunity for life.

Infantile Paralysis may occur in adults as well as children. It comes on suddenly with fever and a sick stomach, and in about three days a leg, arm, foot, hand or the back becomes paralyzed, and the victim is unable to move that part of the body. In a few cases the heart or lungs may be paralyzed, and death results.

The rule for isolation and disinfection should be enforced to prevent its spread. The infection is spread

from the discharges from the patient's nose and throat and possibly the bowels.

Chicken Pox is a mild disease which results in a "breaking out" on the skin. At first they are red spots, but later they become like blisters and a yellow "matter" forms under the blisters. These **pustules** soon dry up and a hard crust (a "scab") is formed. In a few days these fall off and they seldom leave a scar. The infection is in the matter in the pustules and the patient's clothing and bedding should be promptly boiled or otherwise disinfected.

Measles is a common disease occurring usually in children. There are fever, a rapid pulse, a reddening of the eyes, a dry cough followed by a rash of tiny red spots over the body. The rash may first be seen on the "roof" of the mouth or sides of the cheeks. The infectious material is from the nose and throat and it should be carefully handled as in diphtheria.

The danger from measles lies in its after effects of pneumonia or ear trouble. The disease appears about seven days after exposure to one who is ill of it. One attack usually confers immunity.

Disinfection means the employment of certain means to kill germs of disease. Most germs are killed when they become thoroughly dry, but the germs of tuberculosis and lock-jaw (tetanus) may continue to live after prolonged drying.

Sunlight is one of the best **germicides** (agents which will kill germs), because it thoroughly dries them and it destroys their structure. Bed clothing, rugs, and garments used during illness should be thoroughly sunned for days before they are again used.

Heat either by boiling or baking is one of the best

means to kill germs. Boiling for fifteen minutes will kill any germ, and clothing, eating and drinking utensils and any other infected object which can be so treated are best disinfected in this way.

Chemicals are often used to kill germs. It must be remembered that they are poisons and great care must be taken to keep them from getting into food or drink or from being accidently swallowed. Bichloride of mercury (60 grains to a gallon of water) is a good germicide to scrub the floors and woodwork of a sick room and to wipe down its walls. The hands may be washed in this solution and at once be rinsed in fresh water to free them from poison.

Carbolic Acid in a solution of 1/4 of a pint to a gallon of water is a good agent to use for soaking bedding, wiping walls and woodwork of a sick room, and for moistening cloths for receiving discharges from the nose, throat and lungs. Such cloths should be burned after using.

Fresh Chloride of Lime, made by using two ounces to a gallon of water, is one of the best germicides and is probably the best for disinfecting the body wastes of a person ill of typhoid fever, dysentery (flux) and the summer complaint of children.

Gases from the burning of **sulphur,** and boiling a solution of **formaldehyde** are often of value in fumigating a room following disease. Such a procedure is valuable only when all the cracks in the room are sealed up with paper or adhesive plaster and windows and doors fit tightly. The room should remain closed and sealed for twenty-four hours, and all drawers, closets and wardrobes be opened so the gas can reach their recesses.

A pound of sulphur may be placed in a large tin pan

which is placed on bricks inside of a larger kettle with water in it. Alcohol may be poured over the sulphur and set on fire. The sulphur in burning gives off a gas which unites with watery vapor and forms a powerful germicidial gas.

A pint of formaldehyde, as bought at drug stores, may be placed in a vessel over a coal oil or alcohol stove in a room to be disinfected. When the solution boils the formaldehyde gas is given off in the room and under proper conditions will kill most germs in twenty-four hours. Gases should not be used alone. The scrubbing of floors, woodwork and walls are of much more value.

CHAPTER XLIV

SANITATION

In the preceding chapters it has been learned that certain rules must be observed if the body is kept well and free from many kinds of sickness. There was also shown the need of carefully disposing of the infectious body wastes from sick people in order to limit the spread of disease.

"An ounce of prevention is worth a pound of cure" is an old proverb which applies to many diseases. Such a study of the prevention of disease and the means to accomplish it is embraced in the subject of **sanitation.**

Sanitation of the Home. A dwelling house should be built high enough from the ground to be kept dry. In sparsely settled communities it is best to build it upon a rise of the ground so there is good drainage of surface water away from the house.

The windows and doors should be screened from flies and mosquitoes, and the rooms should be large, well ventilated and lighted.

If possible, a supply of water should be furnished from the city mains, or from an overhead tank from which water may be run through pipes, at least, to the bath room and kitchen. If no sewerage system is at hand, a **septic tank** may be built in the backyard and all waste water and materials can be run from the house into it.

A **septic tank** can be built of concrete and is nothing more than a water-tight tank. A hole about five feet long, three feet wide and four feet deep is dug in the ground, and concrete poured into it until a level bottom, five inches thick, is made. After this hardens, planks may be set on

end all around the hole, four inches from the dirt walls and this space filled with concrete and tamped tight. When this hardens, after two or three days, the planks may be removed and placed across the top, leaving about three inches of the top of the walls bare. Concrete may then be poured across the top four inches thick, leaving one end of the tank open for about one foot across one end. If no house is built over the tank, this hole may be tightly closed and the tank covered with a foot of earth to prevent freezing. A tile pipe may be run into this tank at one end to carry waste materials from the house. At the other end of the tank, tile may be run from it about a foot from the top, under the garden or yard. The oxygen of the air will disinfect the overflow from the tank.

If no water is furnished in the house for the bath tub and toilet, a screened house may be built over the tank, using the top of the tank for the floor of the house. Such an outhouse should be so arranged that flies or rats cannot carry foul material into the house, and it should be kept clean.

The tank must be water-tight so that drainage from it may not seep into the cistern, well or spring.

If every home and public building were supplied either with such a septic tank or connected with a good sewerage system, such diseases as typhoid fever, dysentery and hookworm diseases would largely disappear.

Concrete may be made by mixing one part Portland cement, two parts fine sand and four parts of coarser gravel or finely crushed rock with plenty of water. When ready for use, the mixture should flow like molasses. Too little water will cause a leaky tank.

Garbage is a term applied to waste and refuse from the

kitchen. Such materials in a well governed city are placed in large garbage cans and hauled away by the city.

In smaller towns and in out-of-town homes, much of it is fed to hogs and chickens. When fed to animals it should be carried away from the house so that the odors of its decomposition may not be detected, and fed on the slope of a hill draining away from the source of water supply.

The waste water from the kitchen may be run into a septic tank. If not fed to animals, the solid or "dry"

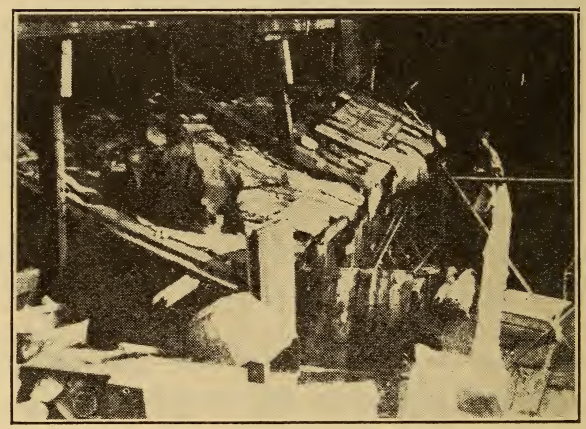


Fig. 151.—A filthy, unsanitary backyard. A breeding place for disease just across the alley from a sanitary home. Showing why health laws should be enforced.

garbage should either be burned or buried in a trench which will not drain toward the water supply.

The premises about a home should be kept free from weeds which may harbor mosquitoes, empty tin cans, and uncovered rain barrels which offer a place for mosquitoes to hatch. "Wriggle-tails" are young mosquitoes in the

first stage of their life after hatching from the eggs. They may be killed by pouring crude oil on the water.

The back porch and yards should be kept free from rubbish and kept clean and orderly. Remember that filth breeds disease.

Sanitation of the Community. Unfortunately, many people either do not know how to prevent the spread of diseases, or they are too careless or indifferent to do so. One may live in a home which is kept sanitary, but be ex-

Fig. 152.—Boy scouts in a clean-up campaign for community sanitation.

posed to the drainage, flies, rats and dangers of a neighbor's house and premises which are ill-kept and breeding places for disease.

It is not right for any person wilfully to permit the so-called "catching" or communicable diseases to spread, and health laws with penalties are necessary to compel indifferent or ignorant people to protect their own and other people's health and lives.

Health Boards. In larger cities, there is usually a committee of citizens whose duty it is to enforce the health laws. They usually operate through a health officer, whose duty it is to see that health laws relating to them are enforced; that sanitary inspections are made of schools, homes and public buildings, dairies, water supplies, food factories and markets.

There, also, is usually a county board of health and a county health officer, whose duty is to enforce the health laws and rules in an entire county.

Fig. 153.—College girls in a health parade for a clean-up campaign, conducted by the visiting nurse of a County Health and Welfare League.

The State Board of Health is one of the most important departments of the State, for through it, health laws for the entire state are enforced. It is usually able to make free examinations of water, body wastes and discharges from sick people; to help locate diseases and tell of their nature and danger; to make sanitary inspections; to keep

records of births and deaths and direct the health work of the counties.

It is the duty of every good citizen to uphold the efforts of health officials and to insist upon the passage of laws with ample funds for their operation.

Volunteer Organizations. Many cities and counties organize Anti-Tuberculosis Societies, City and County Health and Welfare Leagues for the purpose of nursing the sick and helping them to prevent sickness. Many of them employ one or more **visiting nurses,** who give nursing care to those unable to employ a nurse, and instruct the people in disease prevention; they visit schools and instruct pupils in hygiene and examine them for defective eyes, teeth and hearing and for adenoids and tonsils.

The visiting nurse encourages victims of tuberculosis by showing them how to get well and live in safety with the family, and persuades many to go to a tuberculosis sanitorium for treatment and instruction in the management of their disease.

Many schools organize Junior Health and Welfare Leagues, and elect one of the pupils as school health officer. The school board of health is composed of a few pupils and it is their duty to see that the rules for ventilation and cleanliness of the school room are enforced; that the common drinking cup is not used; the necessary outhouses are kept clean and in a sanitary condition; that spitting upon the floors is not permitted and to enforce the rules against sneezing and coughing with the nose and mouth uncovered.

The members of the school health board and the health officer are changed from time to time and offenders against the health laws of the school are required by the teacher to perform some task that will be in keeping with the

offense committed. Often the offender against the rules may be tried by a jury of pupils and the teacher explains the offense and why it should not have been committed, and the reason for inflicting a penalty.

The Modern Health Crusader Movement in schools provides a series of promotions and prizes for pupils who will for a number of weeks perform ten health tasks each day.

Tuberculosis Sanatoriums have been built by many states to provide for the instruction and treatment of this disease.

The cost to the state is small compared to the loss in life and health of its citizens.

Such institutions have been erected by many counties, fraternal organizations and volunteer organizations.

The average time a consumptive should remain in a sanatorium for the disease to be arrested or cured is about six months. After such a treatment a patient has learned so well to protect himself and others that he may live in safety with his family and friends.

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